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HIGH TECHNOLOGY BUSINESS

OCTOBER 1988

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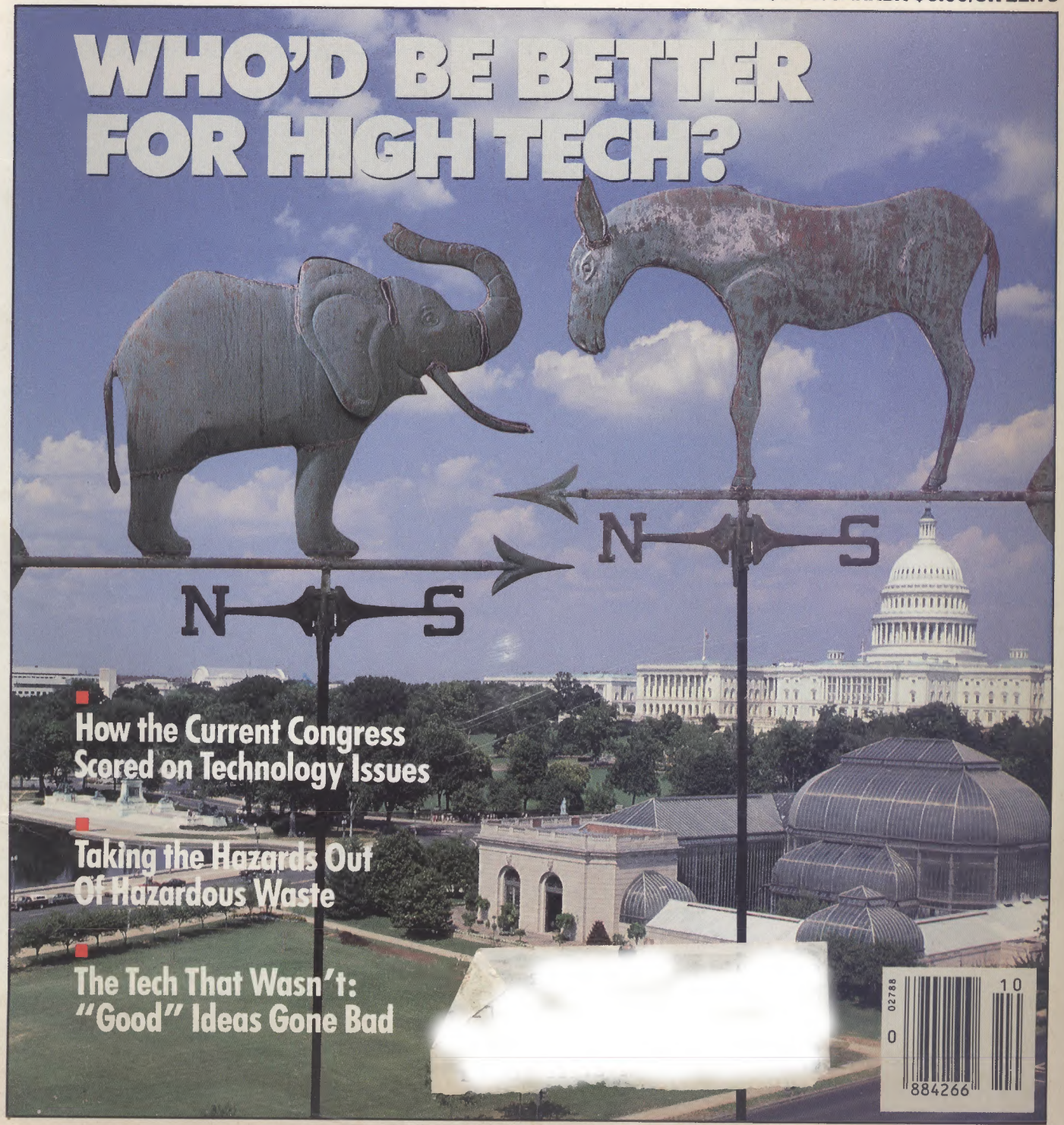

- How the Current Congress Scored on Technology Issues
- Taking the Hazards Out Of Hazardous Waste
- The Tech That Wasn't: "Good" Ideas Gone Bad

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Time for Cliches–And Realities

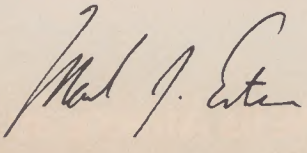
You know it's presidential election season when the cliches flow so freely. This year, the predictable polemics about American competitiveness include the usual calls for solving our problems by protecting our industries against unfair competition from other countries—or avoiding such protectionism in the name of free trade; for developing our service sector, where the majority of job creation goes on and where we compete effectively—or finding ways to revitalize our manufacturing capacity, which has brought our economy to its present level of strength; for developing a nationwide industrial policy—or for getting the government further off the backs of corporations.

Is any of this debate useful? Does it matter to the field of high-technology business whether our next president is named Bush or Dukakis? That's what we set out to determine in "Who's Better for High Tech?" beginning on p. 18.

Of course, it is frequently argued that the occupant of the White House matters less than does the makeup of Congress—so we have put together our own list of major pieces of recent high-technology legislation and compiled an exclusive table showing how current members of Congress voted on those bills (p. 23). The aim is to give you a capsule picture of which lawmakers tend to support high-technology business and which tend to be less favorably disposed to it, to help you be better informed when voting than you would be by simply listening to campaign rhetoric.

And speaking of rhetoric, can you remember all the great claims made only a short while ago for fusion power, rotary engines, and Josephson junctions? If you can't, you're not alone. Those are some high-tech inventions, once thought to have great promise, that represent classic mismatches between technology and the marketplace. It can be fun to look back at exaggerated claims for high technology and think how much less naive we are about such things today. But it also makes sense to wonder which highly touted developments of 1988 will one day soon be as dead and unmourned as eight-track tape players. Our cautionary tale begins on p. 38.

For other cautionary tales, look at the enormous problem of hazardous-waste disposal, and the high-tech solutions being tried to head off new Love-Canal-style disasters (p. 26); and at the potential—and potential problems—of expert systems in our highly litigious society (p. 32). The effect that the next President and Congress can have in these areas may be impossible to predict, but—to use one of the favorite cliches of this political season—there is no doubt that whoever is elected will have a very big job ahead of him.



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Introducing Wells American's CompuStar® Multi-Bus Business Computers. The world's first and only multi-processor, convertible bus™ microcomputers.

Ask any computer expert about what type of system you should buy nowadays and you'll likely get a "pass the bus" response. Something like — "Well, uh, the PC/AT* bus is your best buy but, then again, the new PS/2* bus may become the next industry standard." Great advice, right? If trying to decide on a processor weren't tough enough, now you're expected to pick a bus, too.

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The all new CompuStar® from Wells American not only lets you interchange microprocessors, you can also mix and match buses — a PC/AT bus, a PS/2 bus or. . .both. As your computing needs change, simply snap in a new processor or add an extra bus. You'll never again have to worry about buying the *wrong* computer system!

FOUR COMPLETE SYSTEMS IN ONE.

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CONVERTIBLE BUS? YOU'RE KIDDING!

No, we're not. In fact, it may well be the most practical microcomputer innovation ever. Say you've selected an AT compatible CompuStar and later want to add PS/2 compatibility. No problem! Snap in a PS/2 Bus and Adapter Module and you can use *both* buses in the same system. Likewise, if you've selected a PS/2 compatible CompuStar and decide you want to add an AT bus, just snap in an AT Bus Module. Depending on configuration, the CompuStar can have up to *13* bus expansion slots — all AT slots, all PS/2 slots or a "split-bus" of AT *and* PS/2 slots. Best of all, you can reconfigure your CompuStar whenever you want.

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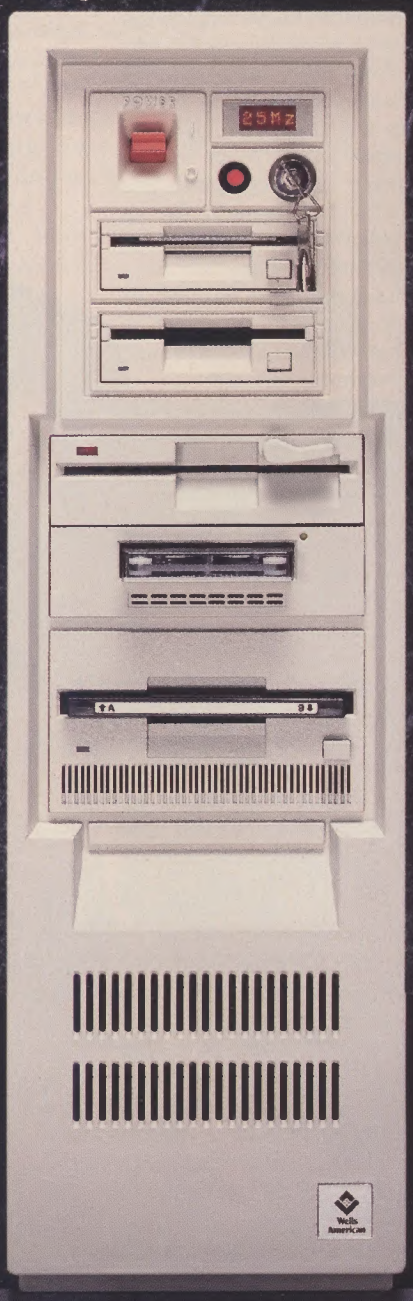

The CompuStar is also easily expanded. That's because there are *seven* CompuStar disk/tape compartments — six accessible from the front and an additional full-height bay inside. All this in a sleek, compact tower design that actually leaves *more* room on your desktop than any of the so-called "desktop" models.

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Think all this technology sounds expensive? It's not. CompuStar 20MHz 80286 systems start as low as $1995†. There are also inexpensive 8086 and powerhouse 25MHz 80386 systems available. Plus, there is a wide variety of CompuStar display, tape and disk options including a one gigabyte erasable optical disk. You can choose a factory preconfigured CompuStar or custom design one yourself. Just unlock the front panel and literally "snap-in" a bus, CPU or disk module in a matter of seconds. It's system flexibility never before available. . .at *any* price.

While one of our competitors (we won't mention any names) threatens you with "missing the bus," most simply *pass* the bus. Our new CompuStar however, *eliminates* the bus problem altogether. Not to mention the processor problem. Even the expansion problem. Prove it to yourself. Call today about our CompuStar 31-day trial offer. Oh, and by the way, the next time anyone asks, tell 'em you know where the bus stops.

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OCTOBER 1988
VOL. 8, NO. 10

Cover weather vanes created for Salt & Chestnut by MacQuarrie-Micniccum, photograph by Bob Arruda. Background photograph by Maxwell Mackenzie/Uniphoto.

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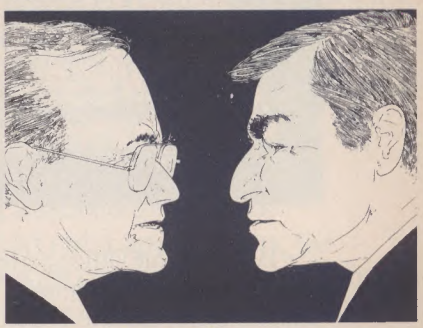
Legal trouble looms for expert systems, p. 32.



Face to face on high-tech issues, p. 18.

Technologies that fizzled, p. 38.

■ Space Business

FRANCESCA LUNZER'S July article "Space Business on the Rise" was encouraging in that it mentioned that private enterprises are trying to to fill the costly vacuum created by government boondoggles, past and present. The government can no more provide cost-effective entries into space than it can provide cost-effective postal services, mass transit, electric power, or a superconducting supercollider. People in government assume the powers of taxation and regulation, which lead to little choice, shortages, and high costs.

Robert Poole, in a paper from a 1984 space conference in Dallas sponsored by the National Center for Policy Analysis, writes, "... government space programs have created a highly misleading impression that space development is more costly than it needs to be. If venture capital is to be attracted to space, it is important that government's central role be drastically reduced."

Is it true that only the government can afford to take man into space?

Chris Rivnak
Dallas, Texas

■ Technology Champions

I ENJOYED very much your June cover story that listed the top 10 companies in the country based on their use of technology ("America's Technology Champions, p. 22"). I was especially pleased to see Du Pont listed, as it is a primary client of our engineering and building-services company. Du Pont's profitability as a percent of sales would certainly be impressive, and I expect you missed their sales by a factor of 10.

Gary D. Jones, President and COO
MK-Ferguson Company
Cleveland, Ohio

Editor's note: *Mr. Jones is correct; our decimal point strayed. Du Pont posted 1987 sales of $30.5 billion, not $3.05 billion as on p. 29 of our June issue.*

We welcome comments from our readers. Address letters to Editor, HIGH TECHNOLOGY BUSINESS, 214 Lewis Wharf, Boston, MA 02110. We reserve the right to edit letters for length and clarity.

Photographs that show features one three-thousandth the width of a human hair have been obtained through the latest advances in miniaturization technology. The photographs were achieved with a microscope using a focused ion beam that scanned nickel crystals at 80,000 times their actual size. The images revealed features as small as 15 nanometers, equivalent to approximately 100 diameters of an atom. Used as a fabrication tool, the focused ion beam can produce the structures required for ultra-small microelectronics. The technique, developed by Hughes Aircraft Company, will be used in applications for ultra-small structures to produce improved microwave sources and amplifiers, faster integrated circuits, higher speed photodetectors, and new devices utilizing superconductive materials.

A Hughes-built probe descending through Jupiter's atmosphere will provide never-before-gathered data on its chemical composition, temperature, and density. The Galileo Mission, to be launched in 1989, will arrive in the Jovian system in 1995 for a two-year tour, after traveling a lengthy route including Earth and Venus fly-bys. The Galileo orbiter will release the onboard Hughes probe into Jupiter's atmosphere. It will descend by parachute, sending its scientific findings to the orbiter which will then relay them back to Earth. The orbiter will continue on its tour and pass within 600 miles of Io, the most volcanic body in the solar system, which pumps more than a ton of ash into space every second.

A new microwave modulated fiber optic link can modulate light from zero to 17 billion cycles per second, a world record. With this bandwidth, the link can accomodate the entire radio band, the TV band, and all the satellite communications bands. Developed by Hughes, this device has the capability to transmit the entire Encyclopedia Brittanica in one-tenth of a second over a fiber approximately the size of a human hair. Intended for satellite terminal and radar applications, the device achieves a 20 decibel greater dynamic range than can be realized with conventional laser current modulation techniques.

A new radar system is used to measure the radar reflectivity of an object. The radar cross section (RCS) measurement system can reproduce a two-dimensional image of a target, such as an aircraft, and the information can be used to help redesign the aircraft to reduce its visibility to enemy radar, resulting in "low observable," or stealth-type vehicles. The Hughes RCS system is universal and programmable, and is designed to take measurements over a broad band of microwave frequencies, from 0.1 to 100 gigahertz. The system can thus tell the user how visible a target would be to the "eyes" of any radar in the world.

Hughes is seeking experienced engineers and scientists to further develop advanced spacecraft systems and components for communications satellites. Openings are in the fields of: software, computers, and data processing systems; electrical components; microwave/RF communication systems development; on-board spacecraft electronics and control systems; satellite design, integration, propulsion, and electrical power system development; spacecraft manufacturing, systems test and evaluation; GaAs applications R&D. Send your resume to Michael Martinez, Hughes Space & Communications Group, Dept. S2, S4/A300, P.O. Box 92919, Los Angeles, CA 90009. Equal opportunity employer. U.S. citizenship required.

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New Developments

Issues, products and advances that help create new opportunities for high-tech businesses

Junkmail Comes By Fax

IT TIES UP telecopiers, wastes thousands of sheets of $13-a-roll fax paper, and, like its low-tech counterpart, is often useless and generally annoying. Even so, "junkfax" is a fast-growing business communications tool.

It's the lastest telemarketing/direct-mail gimmick—unsolicited telecopies sent to the approximately one in ten U.S. businesses that now use a facsimile machine. Devotees claim that fax messages are an easy and effective way to reach a growing number of companies. Response rates are said to be much higher than those elicited by standard direct-mail campaigns and, when sent during off hours, faxing can be cheaper than mailing.

Companies that specialize in junkfax can choose from three or four directories that list fax numbers. Tom Jensen, editor of *FaxFocus*, an industry newsletter, says fax machines are even used to solicit other fax numbers. Jensen recalls that his office once received a fax from a telemarketing firm that offered a free cooler in exchange for a fax transaction list with 20 fax numbers on it. "We didn't do it," he says.

Jensen says he receives about a half-dozen calls a week from people asking how to establish a fax direct-mail program. "I don't encourage them," he says. "It's an annoyance, and it's an annoyance you pay for." Junkfax may be the ultimate example of a message that isn't worth the paper it's printed on—the office that receives the message may pay more for the paper used than the sender paid to transmit the message.

HAL MAYFORTH

To control unwanted faxes, future machines might be equipped with a termination function that lets owners disconnect the transmission at any time, or perhaps call-screening functions to accept calls only from an approved list of numbers, says Jensen.

—Kenan Woods

And Now, Digital Paper

IF ALL BIG things were small, and all expensive things were cheap, Digital Paper would be right at home. This storage medium, developed by ICI Electronics, packs vast amounts of data into a tiny space for pennies a megabyte by applying optical-disk technology to an inexpensive surface.

Digital Paper stores information by using an infrared laser to permanently burn tiny pits into a reflecting surface; a low-power laser reads the pits to retrieve the data. But instead of a laser disk's surface of aluminum oxide on plastic, ICI Electronics uses dye polymer paper, which costs much less. More savings result from the manufacturing technique—the company makes Digital Paper in rolls, instead of one batch at a time.

Bernoulli Optical Systems of Boulder, Colo., is developing a 5¼-inch floppy-disk drive for a Digital Paper disk that will store one gigabyte of data—800 times the capacity of a magnetic floppy the same size. The Digital Paper disk will retail for about five and a half cents

■ CD recorders may challenge DAT
■ Electricity stops bridges from crumbling
■ Tests keep viruses out of the blood supply

per megabyte, compared to about $1.50 on a magnetic disk. The system, aimed at workstations and personal computers, will be available in late 1989.

Another company, Canada's Creo Products Inc., is working on a Digital Paper tape drive that will hold a terabyte—a million megabytes—on a single reel. This $200,000 device is due out by the middle of next year. The Digital Paper tape system will store data for about a half a cent per megabyte; IBM 3480 tape cartridges cost about three cents per megabyte.

—Jennifer Christensen

More Punch For Pesticides

A NEW delivery system should extend the killing power of genetically engineered pesticides.

The MCap system, developed by Mycogen Corp. of San Diego, Calif., uses a naturally occurring insect-killing gene inserted into selected bacteria. After the bacteria multiply, they are killed and their cell walls stabilized to create a microscopic capsule around the pesticide. These tiny capsules can be sprayed on crops just as conventional pesticides are; insects die when they eat the sprayed crops.

MYCOGEN CORPORATION

can't match MCap protection.

The capsules help keep the pesticide from degrading, so MCap stays effective two to five times longer than commonly sprayed biopesticides, according to Jerry Caulder, Mycogen's president. Even though MCap will cost more per dose to use, farmers won't see increased costs because they won't have to spray their crops as often.

One of the first uses for MCap will probably be delivering M1, a genetically engineered bacteria that is the only known pesticide for fighting the Colorado potato beetle. MCap should be introduced in 1990, pending approval from the Environmental Protection Agency.

—Francesca Lunzer

Ship Design Cuts A Wide SWATH

THE SWATH ship design, patented by Professor Ludwig Seidel in 1979 and now being developed by Pacific Marine, promises to prevent seasickness, even in rough water.

The innovative design, named for its small waterplane area, twin-hull configuration, places a platform resembling a conventional ship on top of two hulls that house the ship's engines. The hulls travel 10 feet under water, and two struts connect each hull to the platform. A third hull on the bottom of the platform does not touch the water in calm seas.

SWATH ships do not bob up and down on the water as do conventional ships. The platform rides above the waves while the submerged hulls sit beneath the waves. This drastically reduces roll, pitch, and heave in rough waters, virtually eliminating seasickness in passengers and crew. Because only the struts cut across the water surface, a SWATH ship can maintain up to 90 percent of its speed in rough water.

SWATH ship designs are as varied as automobile designs. There have been many patents on similar designs, one dating as far back as 1880. For example, for the past 15 years, the U.S. Navy has operated an experimental SWATH ship, the Kaimalino (which means "calm seas" in Hawaiian).

Navatek Ltd., a subsidiary of Pacific Marine in Honolulu, has obtained the first commercial American Bureau of Shipping approval for its plan for an inter-Hawaiian-island fleet. Navatek is developing three basic SWATH ship designs and hopes to see a $2-million test ship plying commercial waters by 1990. Pacific Marine is subsidizing 30 percent of the predicted $20-million cost of Navatek's proposed fleet of six ferries.

—Julie C. Springer

PACIFIC MARINE

SWATH ship's submerged hulls ride smoothly in rough seas.

Trash: The Cleaner Fuel?

AS AMERICA creates ever more garbage—158 million tons of solid waste a year—landfills are reaching capacity. Meanwhile, energy costs are expected to rise again. A solution for both problems is to burn trash for fuel.

A machine invented by John Mayberry, program manager at the Idaho National Engineering Laboratory in Idaho Falls, may make trash a better fuel. His vibrating-mesh screen conveyor separates trash that will burn from trash that won't—or smaller pieces from larger ones—and mixes the garbage into fine particles. As one part of the fuel-making process, the machine removes grit from what will later become a solid fuel. Jack Lyman, director of resource-recovery programs at the National Solid Waste Management Association in Washington, says this solid fuel may help replace coal in steam boilers used to make electricity.

Mayberry says his machine, due on the market next year, will turn out the same quality fuel and be cheaper than existing garbage-to-fuel technologies. The system will cost about $25,000 and would be appropriate for non-utility companies considering cogeneration of electric power.

—Elizabeth Aaron

CD Recorders to Challenge DAT

LAST APRIL'S announcement by Tandy Corp. of its erasable compact disc has sparked widespread speculation about what effect the technology will have on digital audio tape (DAT).

Tandy's innovation is called THOR, for Tandy high-intensity optical recording. Both THOR and DAT are designed to record and play back digital music. A DAT player acts as a super cassette deck; THOR would provide the equivalent of making your own records.

The introduction of DAT recorders has been slowed by legal challenges from the U.S. recording industry,

STEVE WEBER/STOCK BOSTON

Erasable CD on the horizon.

which fears unauthorized duplication. With THOR on the horizon, some observers think the DAT market window may be closing.

On the other hand, THOR is still undeveloped. Tandy acknowledges that a practical consumer product using the new technology is a couple of years away. DAT technology is already here.

"To make an announcement and admit you are 18 to 24 months away from any product just muddies the water," says Len Feldman, a senior editor of *Audio Magazine*. DAT manufacturers say that recording compact discs are still so far off that they will have plenty of time to create their market.

Because DAT technology is so complicated, prices will be high, and CD recorders could undercut the DAT market before it gets established. Japan's Teac, which planned to ship the first home DAT recorders to the United States this summer, will charge about $6,000 for its machine; Tandy expects its home CD recorder/players to cost about $500.

Despite the big price difference, CD recorders will probably hit many of the same roadblocks that are slowing the advent of DAT. The Recording Industry Association of America opposes *any* technology capable of making a digital reproduction of recorded materials, no matter what the medium.

Battles over standards and long development times will also provide breathing room for DAT. Research consultant Marc Finer says that, in the meantime, "DAT technology has not stood still. Currently in its second and third generations, the technology has been embraced by a number of manufacturers and will be improved."

—Kenan Woods

ELGARD

Electrified wire mesh in concrete.

Wiring Bridges Against Corrosion

ELECTRICITY can help restore old bridges and prevent corrosion on new bridges. Cathode protection, first developed in 1973, is now finding wider acceptance as the only method that completely halts corrosion of reinforced concrete.

Concrete is reinforced with wire mesh to add strength, but the mesh is vulnerable to rust. Running a weak electric current through the mesh neutralizes the corrosive effects of salt on the steel structure, making the structure virtually crumble-proof.

Road salt often soaks into the concrete, where it decomposes. Chloride ions produced by the decomposing salt corrode the steel in the concrete, producing cracks. Once the first cracks occur, more salt can get in, hastening decay.

Cathode protection now costs about $3 per square foot—considerably less than the $10 per square foot cost of the first application to a California bridge in 1973.

The method can also be applied to parking garages, tunnels, pipelines, and storage tanks. With federal bridge-repair bills for the next decade estimated at $50 billion, companies that specialize in bridge restoration, such as Elgard Corp. of Chardon, Ohio, and RayChem of Menlo Park, Calif., stand in the midst of a market that is doubling yearly.

—Jennifer Christensen

Tests Guard the Blood Supply

SEVERAL companies have designed better tests to detect viruses in donated blood.

Abbott Laboratories and Du Pont have each developed kits that screen blood for HTLV-1, a virus that can cause a rare form of cancer. The companies expect to win FDA approval this year. The market for HTLV-1 testing of the 12 million pints of blood donated in the United States each year could reach $50 million.

On another front, Chiron Corp. of Emeryville, Calif., has isolated the virus for non-A, non-B hepatitis, which causes liver disease in thousands of blood recipients each year. Chiron is developing a test to detect the virus in blood and plans to begin human trials this year. If used to check both donated blood and people, the test could bring in $85 million annually, says a spokesman. Ortho Diagnostics, a Johnson & Johnson subsidiary, will market the test.

These tests represent only the opening shots in the war on viruses in the nation's blood supply. "We're often a step behind the viruses," says Dr. James Aubuchon, a medical officer in the blood-services department of the American Red Cross. Aubuchon says the National Institutes of Health will be funding research into ways to neutralize viruses in the blood, including ultraviolet irradiation. Another potential tactic would split blood into components and discard the white cells, which often carry viruses, before giving the blood to a patient.

—Francesca Lunzer

Easier Tests For Diabetics

DIABETICS may soon have an easier way to measure their blood sugar.

Many diabetics must take blood, saliva, or urine samples to determine how much food and insulin they should consume. Biocontrol Technology Inc. of Indiana, Penn., in conjunction with scientists at Battelle Memorial Institute of Columbus, Ohio, and Toronto's Hospital for Sick Children, is working on a noninvasive method to measure glucose in the blood. Patients would simply touch the instrument to their skin for a numerical readout of their blood-sugar level. The company expects the device to also measure cholesterol and drug levels.

Biocontrol Technology hopes to produce a hand-held prototype of the breadbox-sized unit within a year. President and COO John Roche won't specify the technology, but says the next step is to link the device to an implantable insulin dispenser, which has already proven successful with animals, and then create a totally implantable glucose sensor and insulin dispenser. Roche hopes that these second and third phases will be complete by 1992, depending on FDA approval.

Biocontrol estimates it will spend $11.1 million to develop the three projects, including marketing and manufacturing. Roche predicts the home tester to cost about $2,750; a hospital version will run about $10,000. He says Biocontrol has begun talks with several companies, including a Japanese firm, to license the technology.

—Elizabeth Aaron

Fighting Phone Phreaks

TELEPHONE companies are getting together to help stop outlaws known as phone "phreaks."

These outlaws—who usually have a personal computer, modem, and speed-dialers—break into phone-company networks and gain access to credit-card numbers. They then use those numbers to make long-distance calls. Some estimates indicate that phreaks are depriving long-distance companies of as much as 10 percent of industry revenue.

Telephone companies have developed a system to fight back. Details vary from company to company, but the goal is to immediately detect the phreak's attempt to break the network code, cut off the search, and provide tracing information such as the phone number, name, and address of the hacker. The companies have agreed to immediately notify each other of which lines are under assault.

LiTel Telecommunications of Worthington, Ohio, claims to have reduced losses from about 2 percent of revenues to 0.02 percent in the past year by using the new system. The system paid for itself in a month, says fraud-control manager Judy Betts.

—Jennifer Christensen

ALSO WORTH NOTING

THERMEDICS

Artificial heart wins funding.

■ The National Institutes of Health (NIH) announced in early July that it *will* fund the development of an artificial heart, a project in which the NIH has invested $239 million since 1964. The NIH had originaly planned to discontinue funding the research, but backed down in the face of a Congressional outcry. Doctors have implanted artificial hearts in five patients; all five died soon after receiving them. The NIH also plans to fund research on left-ventricle assist devices (LVADs), which support failing hearts until a human heart can be found for a transplant. The companies first in line to receive NIH grants for LVADs include Thermedics of Woburn, Mass.; Abiomed of Danvers, Mass.; Nimbus Medical Inc. of Rancho Cordova, Calif.; and Novacor of Oakland, Calif.

■ The biotech industry may be slowing down. Since the industry began with a bang in the early 1980s, fewer new companies are joining the industry. According to the National Science Foundation, 200 new businesses that focus on biotechnology were formed between 1980 and 1984, but that rate has now slowed to about 20 a year. However, existing players are becoming more self-sustaining. In 1987, 80 percent of the funding for biotech research and development came from the companies themselves, up 4 percent from 1986.

■ Telecommunications can be a burdensome expense for many industries, but a recent survey shows that banks and airlines carry the heaviest load. According to the International Communication Association's annual report, which surveyed 178 member companies, airlines and banks spend the most on telecommunications when calculated as a percent of their total revenue. Airlines shell out 2.05 percent of their revenue; banks, 1.33 percent; office-equipment/computer companies, 1.32 percent; and transportation companies, 1.31 percent. Banks and bank holding companies paid the most as a percent of total company expenses—3.26 percent of operating expenses, almost double the layout of the next highest industry.

■ Sharp Corp. and Philips N.V. have developed an optical pickup for compact-disc players that is 25 percent smaller and 20 percent cheaper than current devices. The pickup—the equivalent of a phonograph needle—reads digitally encoded data from CDs and converts the optical signals into electrical ones. The new unit houses both the laser and the pickup; they are separate elements on current players. The new pickup forms holograms by reflecting laser beams on a glass plate; diffraction patterns in the hologram create the optical signal. Present pickups use a prism to refract and divide a laser beam reflected from a CD's surface. Sharp says that it is planning to ship samples this month.

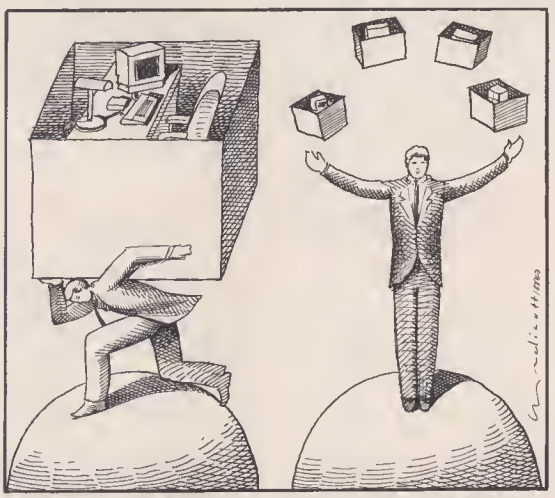
A New Look at the Office

DELIBERATE APPROACH SMOOTHS PATH TO CHANGE

By Robert Chapman Wood

JAPANESE FACTORIES serve as models for the rest of the world, but Japanese offices seem to have been designed by Ebenezer Scrooge. Even at top companies, as many as 20 employees may share a single personal computer. But Japan seems poised to create a radically different environment for business. As in other fields, Japan's vaunted systematic planning could give the country a healthy lead in creating truly productive offices.

American technologists who laughed at Japanese offices in the early 1980s now recognize that their own lavish spending on office technology has added little to productivity. New equipment made traditional office work faster, but may actually impair overall productivity. Training time on word processors, for instance, can easily outweigh the typing time saved. To take full advantage of technology, organizations must restructure their entire operations.



JAMES ENDICOTT

The Japanese believe that such a restructuring will lead to dramatic gains in productivity over the next 10 to 15 years, and Japan's Ministry of International Trade and Industry (MITI) and Ministry of Construction have established the "New Office Concept" program to help make that happen.

The program will try to realize theories such as those of U.S. consultant Duncan Sutherland, who pioneered the rigorous analysis of offices when he started Wang Laboratories' Advanced Systems Laboratory in 1981. The Advanced Systems Laboratory found that U.S. firms had frittered away much of their information-technology spending. Sutherland urged companies to stop thinking about speeding up office work the same way they think about speeding farm or assembly-line work.

Offices are not like factories; most office workers spend most of their time developing and manipulating information. Their real purpose is to support activities that take place elsewhere—in the production, distribution, and sale of goods and services. But today, in both Japan and the West, more people work in offices than in factories, farms, laboratories, or stores. As technology makes information easier to manipulate and communicate, however, fewer executives can support the productive parts of the organizations, with a much smaller staff.

Sutherland has coined the verb "officing" to describe providing an environment for performing knowledge work and communication. Sutherland asserts that companies—and ultimately nations—must focus on creating systems that allow communication to happen "seamlessly."

Americans have largely ignored Sutherland's ideas, but the Japanese are paying close attention. The country has launched a national debate on how to reap the benefits of "officing." Sutherland, who left Wang in 1984, has been invited to make four lecture tours of Japan in the last two years. At each stop, he was introduced by a key MITI official. Matsushita Electric Works, which builds communication systems for intelligent buildings, has co-published in Japanese and English a book, *Officing*, mainly written by Sutherland. "It all boils down to making the creation of 'enabling technologies' a national project," says Sutherland.

In the construction of new, "smart" buildings, MITI and the Ministry of Construction urge businesses to focus on long-term goals. So, while U.S. companies invest to automate today's tasks, Japanese firms are concentrating on flexible equipment that will fit into the restructured world of the future. Facsimile machines and fiber-optic networks in buildings are good examples. Meanwhile, major companies are seeking ways to reach the ideal of seamless communications in their own operations.

Japanese electronics companies such as Nippon Telegraph & Telephone, NEC Corp., and Matsushita Electric Works have created fiber-optics-based communications systems in prototype intelligent buildings for their own use. The fiber-optic cabling would be useful even if another company's equipment was eventually installed a decade or more in the future. In contrast, attempts by U.S. firms such as AT&T to market intelligent buildings have focused on selling today's proprietary networking systems, meeting limited market success.

Japan's institutional planning will be a key to making "officing" a success. "The larger the system, the cheaper it is to operate," contends professor Yoshio Tsukio of Nagoya University. "Accordingly, applications will expand from a single building to a complex, and eventually to an entire city." ■

Robert Chapman Wood is a writer and business consultant who specializes in the economies of the Orient.

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Communicating Better

ADVICE ON FIGHTING TECHNOBABBLE

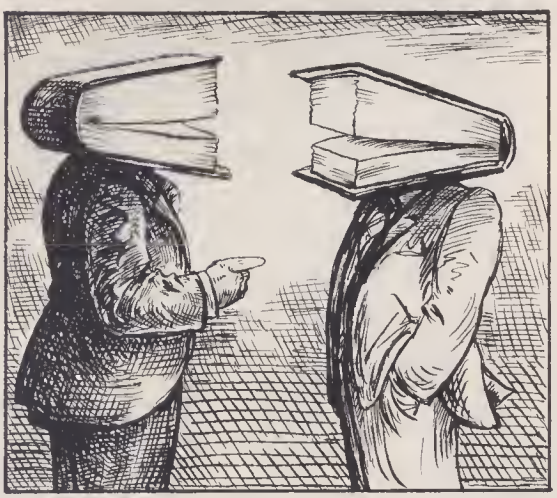
■ **By Mark J. Estren**

How to Talk So People Listen
by Sonya Hamlin.
Harper & Row, 284 pages, $17.95.

Osgood on Speaking
by Charles Osgood.
William Morrow & Co., 132 pages, $14.95.

The Eloquent Executive
by William Parkhurst.
Times Books, 140 pages, $14.95.

Although we live in the Age of Communications, many of us communicate poorly. This is a special problem for anyone involved with high technology, because so many high-tech concepts are complex, abstruse, and unfamiliar to most people. But clear communication is vital, whether you are dealing with outsiders whose funds or expertise can help grow your company, or with superiors or subordinates in your own firm.



TOM LULEVITCH

The greatest clarity-cum-compression to be had these days comes from television, the news medium in which practically any story can be told reasonably clearly in 90 seconds or less. Rather than bemoan the "headline" nature of TV communication, all three authors represented here revel in it. Not surprising: communications consultant Sonya Hamlin appears frequently on TV, Charles Osgood is a CBS correspondent, and William Parkhurst's consulting company specializes in media training for executives.

Hamlin's book, *How to Talk So People Listen,* is the most thorough of these three. Though not written specifically with high-technology businesses in mind, it highlights some of the special problems faced by anyone advocating a new idea, product or approach: "New ideas are usually presented just that way—as *new*. Different. Unlike what's gone before. Bad news! . . . New [information] creates major resistance since one doesn't know how to listen to it, to relate to or even imagine it. [It's better to] start with the familiar and then to add the new as variations or take-offs from the old. To establish and remind one of *what is,* then show how it leads to *what could be.*"

Hamlin uses a chatty, informal style to tackle serious communications issues. Chattiness and informality are also Osgood's hallmarks, and are present in abundance in *Osgood on Speaking,* to the extent that *anything* is present in abundance: the book is very short, set in very large type, and has an unconscionable amount of white space—in word count, it amounts to little more than a pamphlet.

Osgood, targeting speechmaking rather than communication in general, offers pithy remarks that teeter between usefulness and cliche: "If there is a simpler way of saying what you want to say, say it that way." "If you can't keep numbers out of your speech, at least keep them down." "The more confident you are, the more natural you can be." The book is anecdotal, often charming, and very easy to read. But its most useful information is largely distilled from a work that Osgood himself cites: *Professionally Speaking* by renowned communications coach Lilyan Wilder, who has trained people ranging from George Bush and Oprah Winfrey to Osgood himself. Wilder's book (retitled *Talk Your Way to Success* in paperback) is significantly more detailed, and applicable to a wider variety of business situations, than is Osgood's more limited work.

Parkhurst's book, *The Eloquent Executive,* stakes out an uneasy middle ground between Osgood's very brief, single-purpose work and the much more wide-ranging books by Hamlin and Wilder. "Look at television with a new perspective" to improve your communications skills, Parkhurst urges. "The powerful person talks at an even volume . . . Speak at an even level, and be very calculated about your use of the highs and lows."

"Very calculated" pretty well describes Parkhurst's once-over-lightly approach to everything from meetings to business meals to social occasions at which business colleagues are present. Many of his recommendations are good—if you accept his biases: "CEO talk is not full of imagery and rich phraseology—that's too vague. There are no long-distance detours to spare someone's feelings—that's for the shrinks. With top management people, the point is right out front and usually demands immediate action."

Ultimately, of course, the aim of all business communication is to bring about action. Hamlin, Osgood, and Parkhurst offer ways to make what you have to say as clear as possible and so give you the best chance to galvanize your listeners. None of these books will give you instant eloquence, but all can help your words stand out in this era of information overload. ■

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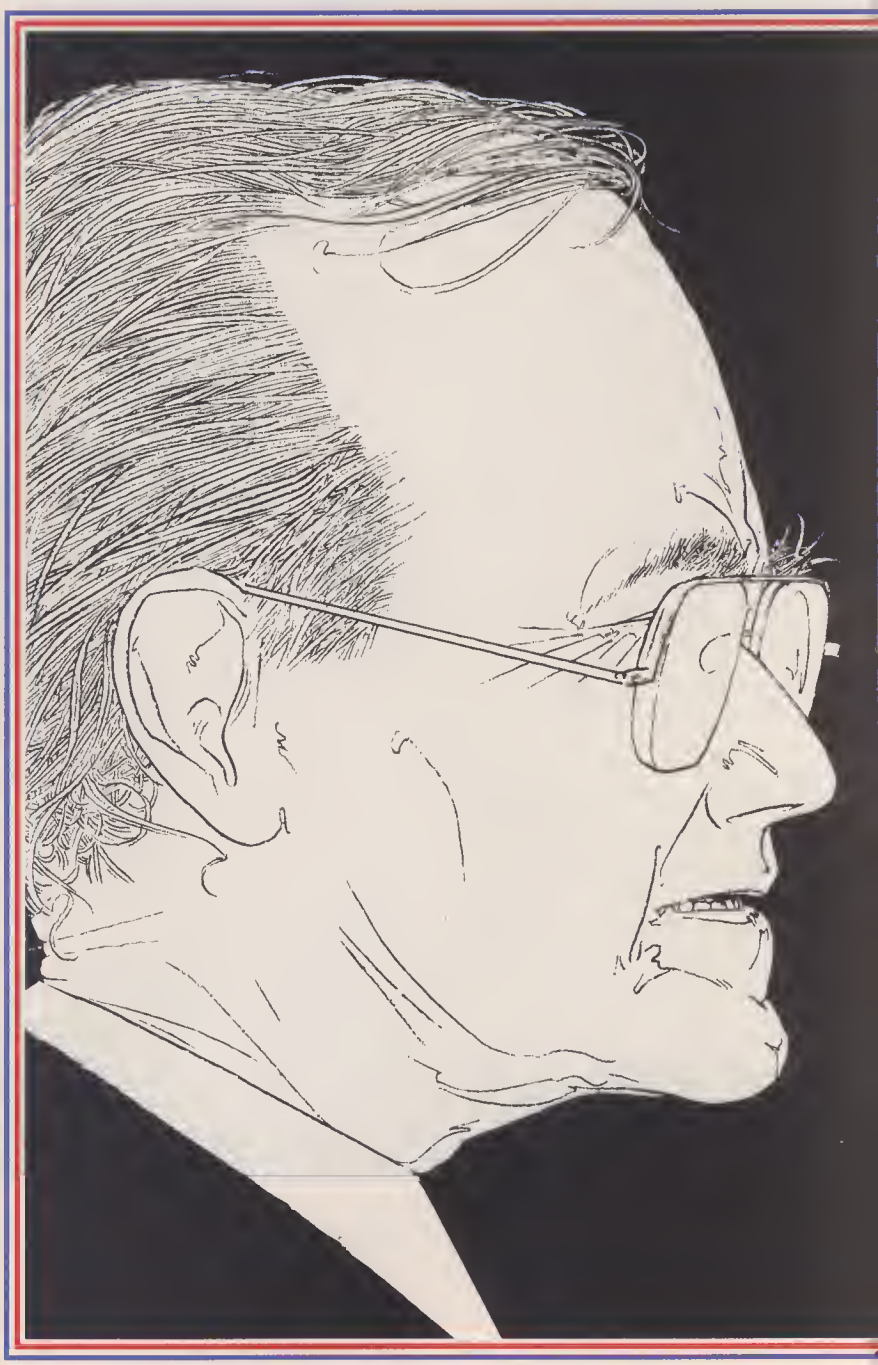


ILLUSTRATION BY DAVID JOHNSON

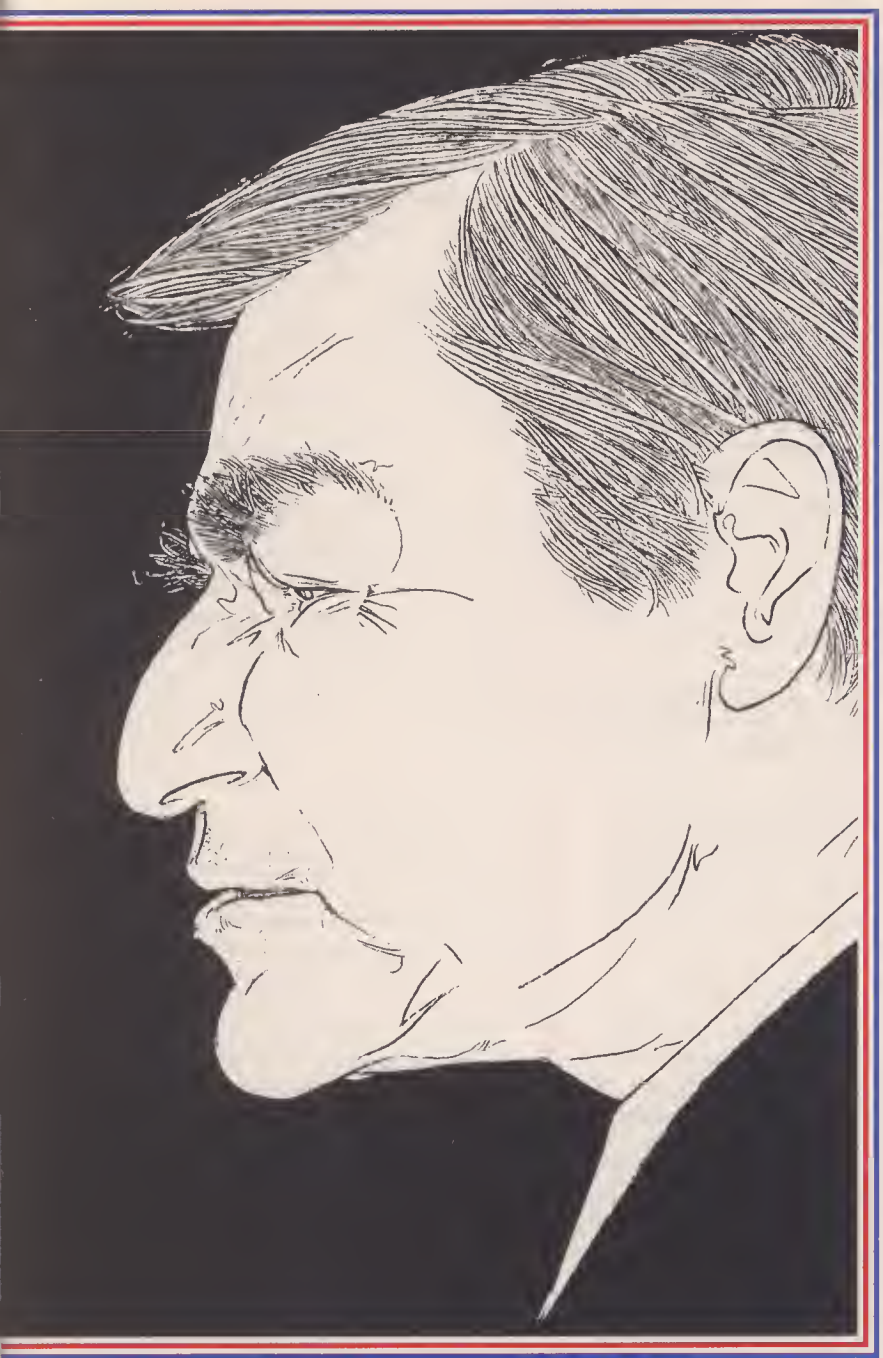
HIGH technology has been a wellspring of the current U.S. economic boom, yet the industry's health is threatened by Japanese competition on one hand and underlying domestic economic ills on the other. The presidential candidates say they're ready with a cure; both George Bush and Michael Dukakis promise that improving America's technological competitiveness will become a top priority for their administrations.

Their prescriptions, however, are short on specifics—let alone risk-taking. Both, for example, promise to appoint a science adviser early in their term of office (Presidents Reagan and Carter didn't appoint a science adviser until well into their terms), and both support continuation of the research-and-development tax credit, which is set to expire this year.

These similarities arise, in part, because both the Democratic and Republican candidates cast themselves as managers rather than visionaries. Each candidate possesses a certain measure of fiscal conservativism, and each is expected to implement change in a cautious manner.

This election presents business executives, especially those with an interest in high technology, with a tough decision to make. This time around, a reflexive vote for the Republican ticket may not necessarily carry its traditional connotation of being a vote for business prosperity. Dukakis has tried to stake out the business of technology as his special expertise.

Dukakis' approach embraces his par-



Whoever wins the presidency will face unprecedented pressure to involve government in high technology

BY ED WARNER

ty's traditional interest in managing the economy. (Which may not always be bad for business; the Kennedy administration, for example, introduced the investment tax credit.) Asserting that government must "invest in the technology of the future," Dukakis has called for partnerships between government, industry, and labor. One such partnership, aimed at regional development, would "leverage" a $500-million governmental grubstake into a billion-dollar development pool, explains Gene Sperling, a member of the campaign's policy staff. Troubled companies chosen by the states would make use of the fund's money to gain state grants or bank loans, says Sperling. Bush's more conservative—and more vague—approach promises to "build on what's happened" during the economic boom of the Reagan years.

One less-pleasant facet of the Reagan years, however, was a 150 percent rise in the national debt, according to Congressional Budget Office figures. That debt is expected to climb to a record $2.58 trillion by the end of this year, and even Bush appears a bit worried. The vice president supports the Gramm-Rudman targets for reducing federal spending, which seek to eliminate $36 billion from each year's federal budget deficit until 1993, when the deficit—but not the debt—would reach zero. Bush also believes that continued economic growth will produce enough new tax revenue to avoid a tax increase. "As president, I will not raise your taxes, period," he maintains.

Dukakis, meanwhile, wants to slash $25 billion to $35 billion annually from

DOES AMERICA NEED A MITI?

When the normally conservative captains of the U.S. high-technology industry come to Washington to beg government's help in a coming battle with Japanese technology, as five CEOs did this summer, you know times have changed.

The call for increased government involvement in promoting U.S. technology business has never been stronger. Among the five CEOs who journeyed to Capitol Hill this summer was Tandy Corp.'s John Roach, who favors a government-funded consortium similar to Sematech, the $200-million government/industry chip-research endeavor. Such a consortium would focus on improving America's position in high-definition television—a technology for producing super-clear TV pictures—in which the Japanese appear to have taken the lead. Other organizations asking the government to take a larger role in promoting U.S. technology include the Aerospace Industries Association, which wants to see expanded research in nine key technologies including advanced composites, and the Institute of Electrical and Electronics Engineers, which has recommended creation of a government agency to coordinate technology.

Congress has responded with two pieces of legislation, both of which would create government agencies for promoting technologies with commercial potential. Bill HR-2958 would create a civilian agency, similar to the Defense Advanced Research Projects Agency (DARPA), to provide grants to promising projects. Bill H-4848, an omnibus foreign-trade bill that will likely be enacted, would convert the National Bureau of Standards into the National Institute of Standards and Technology and give it the power to make research grants to private companies, universities, or partnerships of the two.

This second bill would also create the Competitiveness Policy Council, a 12-member group composed of representatives from academia or public-interest groups, labor, government, and industry. The council would review legislation for its impact on competitiveness, and also bring together leaders of specific industries to solve their problems cooperatively.

Government has long supported research, but largely through specific grants for defense-related or pure-science projects, hoping for commercial spin-offs. Lately, though, government defense research has entered commercial territory; DARPA has earmarked $15 million for semiconductors and $21 million for superconductors. The culmination of this trend is Sematech. Though its work is largely aimed at commercial chip research, Sematech, based in Austin, Tex., is administered by the Department of Defense.

No government agency exists soley to promote commercial research, and none is likely if a Republican administration continues to occupy the White House. A Bush administration will probably also continue the Reagan strategy of funding pure-science research, letting commercialization fall where it may. The National Science Foundation provides grants for pure-science research and the Reagan administration wants to double the agency's budget by 1993, to more than $3 billion.

The National Science Foundation funds five supercomputing research centers and has aimed its largest recent funding increases at computer science. Should Dukakis be elected, the NSF might get more pragmatic.

But some economists doubt that the government is qualified to chose the right targets for research funding. Brian Mannix of the American Enterprise Institute, for instance, believes that "government can't pick the [technology] winners; it gets politicized." A recent report from the Congressional Budget Office also questions the government's ability to pick winners, noting that the "nation's supply of resources used for research and development cannot constantly be increased."

Fred Branfman, director of Rebuild America, the organization established by the five CEOs who came to Washington, says government *can* make the right choices if industry provides the leadership. "We want to see industry pick the winners," he says.

the debt, but has not said how. The Democratic contender also plans to increase federal revenue with expanded IRS enforcement efforts, and to economize by shifting defense spending from exotic to conventional weapons.

Dukakis' solution makes sense to Massachusetts Institute of Technology economics professor Bob Solow, but he worries about tax increases that could hit business investment. Solow says the national debt's climb "was caused by the vast [Reagan] tax reduction and big increases in defense spending."

Bush, however, believes the 1981 tax cut motivated the economic boom of the last five years. While not scoffing at the cost of the defense buildup, Claude Barfield, director of science and technology policy at the American Enterprise Institute (AEI), says conventional weapons are even more expensive than high-tech alternatives, largely because they require more troops to operate them—and troops are expensive. Barfield also claims that high-tech defense research can spawn valuable commercial spin-offs.

But Solow points out that the last major commercial spin-off from defense research was jet aircraft—back in the 1950s. A recent report from the Congressional Budget Office agrees in principle, and notes that the number of spin-offs from defense research has declined as that research becomes more specialized and less revolutionary.

The national debt will also affect interest rates, and that will in turn affect high-technology companies. If the budget deficit begins a diet, economists say interest rates would fall because the government would no longer place such a huge demand on the money market. This summer, the U.S. prime rate—the rate of interest banks charge on loans to their best customers—stood at 9.5 percent, its highest level in two years. Japan's prime rate, meanwhile, was about 3.5 percent.

Pointing to that discrepancy, technology consultant Bruno Weinschel, 1986 president of the Institute of Electrical and Electronics Engineers, says the cost of capital must come down for U.S. business to remain competitive with Japanese companies. Weinschel's list of needed economic repairs also includes improvement of the nation's public education system, particularly a solution to the 30 percent annual high-school dropout rate. "Unless we fix these two basic [problems]," he warns, "anything else

is like rearranging the deck chairs on the Titanic."

Economists doubt that either candidate will try to reduce interest rates by replacing Alan Greenspan as head of the Federal Reserve Board, which sets the prime rate—at least not right away. But Greenspan has promised that the Federal Reserve Board will nudge interest rates higher if inflation appears imminent. With industrial production sitting at its highest level since 1979 and many industries producing at capacity, the nation appears primed for fast growth, and such growth could spark renewed inflation.

Another way to cut the cost of capital would be to encourage Americans to save or invest more of their earnings. The Japanese save 20 percent of their annual income, Americans about 5 percent. To increase the savings rate, and thus the money available for investment, Bush proposes dropping the capital-gains tax ceiling from its current 28 percent to 15 percent.

The national debt's effect on the value of the dollar ties it to the trade deficit, which totaled $135.6 billion in 1987. Although high technology still runs a trade surplus, according to Commerce Department figures, that surplus fell from $27 billion in 1981 to $600 million in 1987. One reason: During the 1980s Japan took the lead in computer memory chips, automotive ceramics, and other fields; some say Japan is now poised to take the lead in superconductors, supercomputers, and high-definition television (see "It Can Happen Here," above).

On trade issues, the candidates differ sharply. Even though the dollar's value is currently low compared to world currencies, Dukakis blames much of the trade deficit on the dollar's 40 percent increase in value during the earlier years of the Reagan administration. Dukakis favors temporary import restrictions to protect vulnerable U.S. industries that are rushing to modernize.

Bush opposes such trade restrictions, claiming that they benefit some businesses "at the expense of the rest of the economy." Among other solutions, the Republican standard-bearer says that the way to improve U.S. competitiveness is through improving the education of its workers. Citing a recent finding by the Hudson Institute that half of all U.S. jobs in the 1990s will require education beyond the high-school level, and that one-third of those jobs will demand college degrees, Bush says he fa-

IT CAN HAPPEN HERE

Imagine a critically important industry in which, 10 years ago, 10 U.S. companies competed, but now only three American players remain. Or a business where, six years ago, the U.S. held almost twice the world market share of the nearest competitor, but has now slipped to second place.

Unfortunately, imagination is not necessary; this scenario has occurred in the computer-memory-chip business. According to Cornell University business-school professor Alan K. McAdams, Japanese electronics companies won a stunning victory by selling memory chips at below-market prices, a practice known as dumping. They financed their $4-billion-plus loss, he says, with earnings from sales of consumer electronics, where they toppled U.S. preeminence back in the 1960s. Now, say McAdams and industry leaders, the Japanese are leveraging their leadership in memory chips to target two technologies with hot futures: high-definition TV, which will offer crystal clear television pictures, and supercomputers, the fastest computers available.

Although U.S. companies such as Cray Research still hold the lead in supercomputers, Japanese companies have made significant progress. In fact, NEC claims to have had the fastest processor chip—the "brain" of a computer—since 1985. McAdams believes Japan's strength in computer hardware means that "the supercomputer [battle] probably has a year or two" to go before the Japanese win outright. In the 1990s, says Yale computer science professor Martin H. Schultz, U.S. companies "may be forced to buy used Japanese high-performance supercomputers if they want to survive."

High-definition TV (HDTV) is particularly worrisome to U.S. industry because TVs are a major semiconductor market, and also because high-resolution picture tubes could be used in computer monitors—potentially giving the Japanese control of another industry. Some observers even fear that the Japanese will enter the U.S. broadcasting business, converting American-made programs to the special HDTV format, then transmitting them via satellite to Japanese-made HDTV sets in the United States.

U.S. and Japanese companies appear to be neck and neck in two other hot areas: superconductivity and high-temperature ceramics. Even though this year U.S. players will outspend the Japanese on research in superconductors—substances that pose little or no resistance to electricity—a recent report from the Congressional Office of Technology Assessment points out that most of that $95 million will go to defense-related research, especially the Strategic Defense Initiative. Japan's $70-million 1988 investment is going entirely to the development of commercial superconducting products, including ultra-fast computer chips. "The short-term view fostered by U.S. financial markets could put American companies behind the Japanese within two or three years, if they are not behind already," the report warns.

Superconductors are usually made with ceramics. Japan already has the lead in electrical ceramics such as capacitors, but observers see new uses for ceramics in aircraft and autos. One market researcher expects worldwide demand for ceramics to grow from $2.1 billion in 1986 to $12.5 billion by the year 2005. Nissan, the Japanese automaker, now uses ceramics, which are light and operate at high temperatures, to make its turbocharged cars accelerate faster; cars equipped with ceramic turbochargers could contribute $500 million to Nissan revenues annually. In contrast, U.S. automakers have yet to commercialize high-temperature ceramics.

American industry's greatest worry is the spill-over effect of Japanese dominance of an industry into related fields. After gaining the lead in memory chips, for example, Japanese chipmakers raised prices as much as 300 percent in one year, causing a drought. Some U.S. computer companies depend on those chips and were unable to meet demand for their products as a result; others had to raise prices. That, of course, made Japanese computers more competitive. According to a recent report from market researcher IMS America, the Japanese share of the U.S. personal-computer market jumped 50 percent between 1987 and 1988.

vors teacher-competency testing and an end to the automatic graduation of high-school students.

Companies such as Texas Instruments already complain of a dearth of qualified manufacturing personnel. "The only solution is to take these people and provide some remedial training," says consultant Weinschel, citing a proposal espoused by Dukakis. Whatever the solution, it will involve money, and neither Bush nor Dukakis have volunteered estimates of how much their respective administrations would spend on such education.

Aside from the effects of general economic maneuvering, both candidates have plans specifically aimed at technology. The fate of the tax credit for increases in research-and-development spending is a good example. Economist Joseph Pechman, a senior fellow at the Brookings Institution in Washington, expects Congress to renew the research tax credit before it expires at the end of 1988. Pechman predicts that the credit will remain in effect throughout the term of whoever next occupies the Oval Office. Bush, in fact, believes the credit should be made permanent.

This tax credit is crucial because, although "research and development is tremendously good for the growth of the economy, the market isn't terribly good at rewarding R&D," says economist Martin Baily, also a senior fellow at the Brookings Institution.

Curiously, even though the research tax credit lets businesses deduct 20 percent of any increase they make in spending on research and development, a recent *Business Week* poll found that corporations across the country would not increase their next year's research budget for the first time in a decade. The Dukakis campaign says this typifies the effects of short-term planning caused by rampant mergers and acquisitions. Dukakis has promised to "get control of the merger-and-acquisition binge that's gobbling up our capital." Bush has taken no public position on the issue, but has said he opposes regulations that stifle competition.

One merger-control measure Dukakis has promised is stronger antitrust enforcement. But economist Brian Mannix of the American Enterprise Institute believes that antitrust regulations should instead be loosened to let U.S. businesses reach the size needed to compete with Japanese monoliths such as Toshiba and Fujitsu. In Japan, he observes, "companies have a way of cooperating with each other that they can't have here." Mannix does acknowledge, however, that the U.S. high-tech boom was largely fueled by the innovations of small companies.

Regardless of who is elected president, observers expect the new administration to help strengthen the nation's safeguards for intellectual property. Earlier this year, a report from the U.S. Trade Commission estimated that computer companies in the United States and other Western countries lost $23 billion in 1986 because of foreign piracy of their technology. Innovations in two hot sectors—microelectronics and biotechnology—are particularly easy to copy, warns Mannix. Unfortunately, many of the products the Japanese have perfected and used to rack up billions of dollars in sales, including semiconductors and VCRs, were licensed legally from their U.S. developers, often at cut-rate prices.

Any action to restrict foreign access to U.S. technological know-how also runs the risk of creating a climate that inhibits the free spread of innovative ideas, and that could hurt U.S. business, says economist Baily. American universities, he adds, would probably oppose any technology-exchange restrictions, even though they "have a huge pool of foreign students who go home and beat the pants off us."

Whether the next four years hold a continuation of tax credits or a bolstering of patent protections, many observers think that such problem-specific fixes are not enough. The United States needs a national agency to handle industrial coordination, an agency similar to Japan's Ministry of International Trade and Industry (MITI), says Cornell University business-school professor Alan K. McAdams. (See "Does America Need a MITI?" p. 20.) But other experts doubt that our government would have enough foresight to choose the right technologies for investment.

Whoever wins the presidency will face unprecedented pressure to involve government in high technology—and will walk a tightrope in attempting to accomplish that goal. As demonstrated by the Carter administration's failed attempt to create a solar-energy industry with tax credits, or the Reagan administration's belated move to curb Japanese computer-chip dumping with tariffs, government action in high technology is often too little or too late. ■

How did your representatives and senators vote on key legislation that affects the high-tech industry?

To find out, HIGH TECHNOLOGY BUSINESS selected the following bills through interviews with trade-association leaders, legislative analysts from Congressional committees, and members of our editorial advisory board.

Obviously, we could not include some important bills. To be fair, we looked only at legislation voted on by the House of Representatives during the last two years—one term of office. In the Senate, we considered bills introduced during the last six years, the term of that chamber.

We also ignored bills that were approved unanimously, such as the Semiconductor Chip Protection Act, or decided by a voice vote, as was the Technology Transfer Act of 1986. In the absence of a roll call, we could not determine the stand of a particular legislator.

We had to ignore important legislation that was approved as a line-item within an omnibus budget bill. A case in point: The Sematech consortium received its $100-million initial funding as part of the December 1987 approval of the "continuing resolution," a 12,000-page working budget for the entire federal government.

Nor could we include bills that were related only to national defense, because a vote for defense is not necessarily a vote in favor of high-technology development. We could not, of course, include the tally for bills that had not been voted on at press time, such as the R&D Tax Credit Extension.

In the chart, an asterisk means that the legislator did not vote.

TECHNOLOGY LEGISLATION SCORECARD

HOUSE BILLS

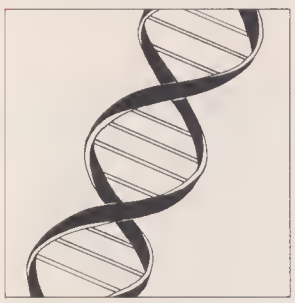
The Trade Bill (H3). Vetoed by President Reagan for its provision requiring 60-day notice of plant closings, this bill would expand protection of U.S. patents on production processes, which is important to biotechnology and chemical companies. Also would have simplified importing and exporting.

The High Risk Occupations Act (HR 162). Would require employers to inform employees of possible exposure to hazardous substances and to pay for medical monitoring, even after employees leave. Did not pass the Senate. A "no" vote considered favorable to technology companies.

The National Science Foundation (NSF) Authorization (HR 4418). Continues the appropriations trend that will double the foundation's budget by 1993. Also establishes science and technology centers at 15 universities to focus on pure-science and commercializable research.

The Defense Department Fiscal 1989 Authorization (HR 4264). An anti-profiteering measure, it lets the government look at profits on government purchases and commercial sales. Passed House; unlikely to pass Senate. A "no" vote considered favorable to technology companies.

SENATE BILLS



The Biotechnology Competitiveness Act (S 1966). Creates the National Center for Biotechnology Information, which will research biotechnology and human genetics. The center would receive $10 million annually through 1993 and would use the money to fund research.

The Superfund Extension (PL 100-202). Requires companies to inform local governments of any hazardous chemicals they produce. Has flooded companies and local government with a mountain of paperwork. A "no" vote would be considered favorable to high technology companies.

The Senate version of the H3 trade bill (S 1420).

The NSF Authorization Act (HR 4418).

SENATE

	S4418	S1420	S1966	PL100202
Bentsen (D-Texas)	Y	Y	Y	Y
Bingaman (D-N.M.)	Y	Y	Y	Y
Burdick (D-N.D.)	Y	Y	Y	Y
Byrd (D-W.Va.)	Y	Y	Y	Y
Chafee (R-R.I.)	Y	Y	Y	Y
Chiles (D-Fla.)	Y	Y	Y	Y
Danforth (R-Mo.)	Y	Y	Y	Y
DeCancini (D-Ariz.)	Y	Y	Y	Y
Durenberger (R-Minn.)	*	N	*	N

	S4418	S1420	S1966	PL100202
Evans (R-Wash.)	Y	N	Y	Y
Garbanes (D-Md.)	Y	Y	Y	Y
Hatch (R-Utah)	Y	N	Y	Y
Hecht (R-Nev.)	*	N	Y	N
Heinz (R-Pa.)	Y	Y	Y	Y
Karnes (R-Neb.)	Y	Y	Y	N
Kennedy (D-Mass.)	*	Y	*	Y
Lautenberg (D-N.J.)	Y	Y	Y	Y
Lugar (R-Ind.)	Y	N	Y	Y

	S4418	S1420	S1966	PL100202
Matsunaga (D-Hawaii)	*	Y	*	Y
Melcher (D-Mont.)	Y	Y	Y	Y
Metzenbaum (D-Ohio)	Y	Y	Y	Y
Mitchell (D-Maine)	Y	Y	Y	Y
Moynihan (D-N.Y.)	Y	Y	Y	Y
Proxmire (D-Wis.)	N	Y	N	N
Riegle (D-Mich.)	Y	Y	Y	Y
Roth (R-Del.)	Y	Y	Y	N
Sasser (D-Tenn.)	Y	Y	Y	Y

	S4418	S1420	S1966	PL100202
Stafford (R-Vt.)	Y	N	Y	Y
Stennis (D-Miss.)	Y	Y	Y	*
Trible (R-Va.)	Y	Y	Y	N
Wallop (R-Wyo.)	*	N	*	*
Weiker (R-Conn.)	Y	Y	Y	N
Wilson (R-Calif.)	Y	N	Y	N

MICHAEL ULLRICH

HOUSE OF REPRESENTATIVES

	H3	H162	HR4418	HR4264
Ackermon (D-N.Y.)	Y	Y	Y	Y
Akaka (D-Hawaii)	Y	Y	Y	Y
Alexander (D-Ark.)	Y	Y	*	Y
Anderson (D-Calif.)	Y	Y	Y	Y
Andrews (D-Tex.)	Y	Y	Y	Y
Annuzio (D-Ill.)	*	Y	Y	Y
Anthony (D-Ark.)	Y	Y	Y	Y
Applegate (D-Dhio)	Y	Y	Y	N
Archer (R-Tex.)	N	N	Y	N
Armey (R-Tex.)	N	N	N	N
Aspin (D-Wis.)	Y	Y	Y	Y
Atkins (D-Mass.)	Y	Y	Y	Y
AuCoin (D-Dre.)	N	Y	Y	Y
Badham (R-Calif.)	*	*	*	N
Baker (R-La.)	N	N	Y	N
Ballenger (R-N.C.)	Y	N	Y	N
Barnard (D-Ga.)	Y	Y	Y	Y
Bartlett (R-Tex.)	N	N	Y	N
Barton (R-Tex.)	N	N	Y	N
Bateman (R-Va.)	N	N	Y	N
Bates (D-Calif.)	Y	Y	Y	Y
Beilenson (D-Calif.)	N	N	Y	Y
Bennet (D-Fla.)	Y	Y	Y	Y
Bentley (R-Md.)	Y	N	Y	Y
Bereuter (R-Neb.)	Y	N	*	N
Berman (D-Calif.)	Y	Y	Y	Y
Bevill (D-Ala.)	Y	N	Y	Y
Biaggi (D-N.Y.)	Y	*	*	Y
Bilbray (D-Nev.)	Y	Y	Y	Y
Bilirakis (R-Fla.)	N	N	Y	N
Bliley (R-Va.)	N	*	Y	Y
Boehlert (R-N.Y.)	Y	N	Y	Y
Boggs (D-La.)	Y	Y	Y	Y
Boland (D-Mass.)	Y	Y	Y	Y
Bonior (D-Mich.)	Y	Y	Y	Y
Bonker (D-Wosh.)	Y	Y	Y	Y
Borski (D-Pa.)	Y	Y	Y	Y
Bosco (D-Calif.)	N	Y	Y	Y
Boucher (D-Va.)	Y	Y	Y	Y
Boutler (R-Tex.)	N	N	*	N
Boxer (D-Calif.)	Y	Y	Y	N
Brennan (D-Maine)	Y	Y	Y	Y
Brooks (D-Tex.)	Y	Y	Y	Y
Broomfield (R-Mich.)	N	N	Y	N
Brown (D-Colif.)	Y	Y	Y	Y
Brown (R-Colo.)	Y	N	Y	N
Bruce (D-Ill.)	Y	Y	Y	Y
Bryont (D-Tex.)	Y	Y	Y	Y
Buechner (R-Mo.)	N	N	Y	N
Bunning (R-Ky.)	N	N	Y	N
Burton (R-Ind.)	N	N	Y	N
Bustamante (D-Tex.)	Y	*	Y	Y
Byron (D-Md.)	Y	Y	Y	Y
Callahan (R-Ala.)	N	N	Y	Y
Campbell (D-Colo.)	Y	Y	Y	Y
Cardin (D-Md.)	Y	Y	Y	Y
Carper (D-Del.)	Y	Y	Y	Y
Corr (D-Mich.)	Y	Y	Y	Y
Chandler (R-Wash.)	N	N	Y	N
Chapman (D-Tex.)	Y	Y	Y	Y
Chappell (D-Fla.)	Y	N	*	Y
Cheney (R-Wyo.)	N	N	Y	N
Clarke (D-N.C.)	Y	Y	*	Y
Clay (D-Mo.)	Y	Y	Y	N
Clement (D-Tenn.)	Y	Y	Y	Y
Clinger (R-Pa.)	Y	N	Y	N
Coats (R-Ind.)	N	N	Y	N
Coble (R-N.C.)	Y	N	Y	N
Coelho (D-Calif.)	Y	Y	Y	Y
Coleman (R-Mo.)	N	N	Y	N
Coleman (D-Tex.)	Y	Y	Y	Y
Collins (D-Ill.)	Y	Y	Y	Y
Combest (R-Tex.)	N	N	Y	N
Conte (R-Mass.)	Y	*	Y	Y
Conyers (D-Mich.)	Y	Y	Y	Y
Cooper (D-Tenn.)	Y	Y	Y	Y
Coughlin (R-Po.)	Y	Y	Y	Y
Courter (R-N.J.)	N	Y	Y	N
Coyne (D-Pa.)	Y	Y	Y	Y
Craig (R-Idaho)	N	N	Y	N
Crane (R-Ill.)	N	N	N	N
Crockett (D-Mich.)	Y	Y	Y	N
Dannemeyer (R-Calif.)	N	N	N	Y
Darden (D-Ga.)	Y	N	Y	Y
Daub (R-Neb.)	N	N	Y	N
Davis (R-Ill.)	Y	Y	Y	Y
Davis (R-Mich.)	Y	Y	Y	Y
DeFazio (D-Ore.)	Y	Y	Y	N
de la Garza (D-Tex.)	Y	Y	Y	Y
DeLay (R-Tex.)	N	N	Y	N
Dellums (D-Calif.)	Y	Y	Y	N
Derrick (D-S.C.)	Y	N	Y	Y
DeWine (R-Dhio)	N	N	Y	N
Dickinson (R-Ala.)	N	N	Y	Y
Dicks (D-Wash.)	Y	Y	Y	Y
Dingell (D-Mich.)	Y	Y	Y	Y
DioGuadi (R-N.Y.)	N	Y	Y	Y
Dixon (D-Calif.)	Y	Y	Y	Y
Donnelly (D-Mass.)	Y	Y	Y	Y
Dorgan (D-N.D.)	Y	Y	Y	Y
Dornan (R-Calif.)	N	N	Y	N
Dowdy (D-Miss.)	Y	Y	Y	Y
Downey (D-N.Y.)	Y	Y	Y	Y
Dreier (R-Calif.)	N	N	Y	N
Duncan (R-Tenn.)	N	N	*	N
Durbin (D-Ill.)	Y	Y	Y	Y
Dwyer (D-N.J.)	Y	Y	Y	Y
Dymally (D-Calif.)	Y	Y	Y	N
Dyson (D-Md.)	Y	Y	Y	Y
Early (D-Mass.)	Y	Y	Y	Y
Eckart (D-Dhio)	Y	Y	Y	Y
Edwards (D-Calif.)	Y	Y	Y	N
Edwards (R-Dklo.)	N	N	Y	N
Emerson (R-Mo.)	Y	N	Y	N
English (D-Dkla.)	Y	N	Y	Y
Erdreich (D-Ala.)	Y	Y	Y	Y
Epsy (D-Miss.)	Y	Y	Y	Y
Evans (D-Ill.)	Y	Y	Y	Y
Fascell (D-Fla.)	Y	Y	Y	Y
Fawell (R-Ill.)	N	N	Y	N
Fazio (D-Calif.)	Y	Y	Y	Y
Feighan (D-Ohio)	Y	Y	Y	Y
Fields (R-Texas)	N	N	Y	N
Fish (R-N.Y.)	Y	N	Y	Y
Flake (D-N.Y.)	Y	Y	Y	N
Flippo (D-Ala.)	Y	Y	Y	Y
Florio (D-N.J.)	Y	*	Y	Y
Foglietta (D-Pa.)	Y	Y	Y	N
Foley (D-Wash.)	Y	Y	Y	N
Ford (D-Tenn.)	Y	Y	Y	Y
Ford (D-Mich.)	Y	Y	Y	Y
Frank (D-Mass.)	Y	Y	Y	N
Frenzel (R-Minn.)	N	N	Y	N
Frost (D-Texas)	Y	Y	Y	Y
Gallegly (R-Calif.)	N	N	Y	N
Gallo (R-N.J.)	N	Y	Y	N
Garcia (D-N.Y.)	Y	Y	Y	Y
Gaydos (D-Pa.)	Y	Y	Y	Y
Gejdenson (D-Conn.)	Y	Y	Y	Y
Gekas (R-Pa.)	N	N	Y	N
Gephardt (D-Mo.)	Y	*	Y	Y
Gibbons (D-Fla.)	Y	Y	Y	Y
Gilman (R-N.Y.)	Y	Y	Y	N
Gingrich (R-Ga.)	N	N	*	N
Glickman (D-Kan.)	Y	N	Y	Y
Ganzales (D-Texas)	Y	Y	Y	Y
Goodling (R-Pa.)	Y	N	Y	Y
Gordon (D-Tenn.)	Y	N	Y	Y
Gradison (R-Dhio)	N	N	Y	N
Grandy (R-Iowa)	N	N	Y	Y
Grant (D-Fla.)	Y	N	Y	Y
Gray (D-Ill.)	Y	Y	Y	Y
Gray (D-Pa.)	Y	Y	Y	Y
Green (R-N.Y.)	N	Y	Y	Y
Gregg (R-N.H.)	N	N	Y	N
Guarini (D-N.J.)	Y	Y	Y	Y
Gunderson (R-Wis.)	N	N	Y	N
Hall (D-Texas)	Y	N	Y	N
Hall (D-Dhio)	Y	Y	Y	Y
Hamilton (D-Ind.)	Y	Y	Y	Y
Hammerschmidt (R-Ark.)	N	N	Y	N
Hansen (R-Utah)	N	N	Y	N
Harris (D-Ala.)	Y	N	Y	Y
Hastert (R-Ill.)	N	N	Y	N
Hatcher (D-Ga.)	Y	*	Y	Y
Hawkins (D-Calif.)	Y	Y	Y	Y
Hayes (D-Ill.)	Y	Y	Y	N
Hayes (D-La.)	Y	Y	Y	Y
Hefley (R-Colo.)	N	N	Y	N
Hefner (D-N.C.)	Y	N	Y	Y
Henry (R-Mich.)	Y	N	Y	Y
Herger (R-Calif.)	N	N	Y	N
Hertel (D-Mich.)	Y	Y	Y	Y
Hiler (R-Ind.)	N	N	Y	N
Hochbrueckner (D-N.Y.)	Y	Y	Y	Y
Holloway (R-La.)	N	N	Y	N
Hopkins (R-Ky.)	N	N	Y	N
Horton (R-N.Y.)	Y	N	Y	Y
Houghton (R-N.Y.)	Y	N	Y	Y
Howard (D-N.J.)	Y	Y	Y	Y
Hoyer (D-Md.)	Y	Y	Y	Y
Hubbard (D-Ky.)	Y	Y	Y	Y
Huckaby (D-La.)	Y	N	Y	Y
Hughes (D-N.J.)	Y	Y	Y	Y
Hunter (R-Calif.)	Y	N	Y	N
Hutto (D-Fla.)	Y	N	Y	Y
Hyde (R-Ill.)	N	N	Y	N
Inhofe (R-Okla.)	N	N	Y	N
Ireland (R-Fla.)	N	N	Y	N
Jacobs (D-Ind.)	Y	Y	Y	Y
Jeffords (R-Vt.)	Y	N	Y	Y
Jenkins (D-Ga.)	Y	N	Y	Y
Johnson (R-Conn.)	Y	N	Y	Y
Johnson (D-S.D.)	Y	N	Y	Y
Jones (D-Tenn.)	Y	N	*	Y
Jones (D-N.C.)	Y	N	Y	Y
Jontz (D-Ind.)	Y	Y	Y	Y
Konjorski (D-Pa.)	Y	Y	Y	Y
Kaptur (D-Ohio)	Y	Y	Y	Y
Kasich (R-Dhio)	Y	N	Y	N
Kastenmeier (D-Wis.)	Y	Y	Y	N
Kemp (R-N.Y.)	N	*	Y	N
Kennedy (D-Mass.)	Y	Y	Y	Y
Kennelly (D-Conn.)	Y	Y	Y	Y
Kildee (D-Mich.)	Y	Y	Y	Y
Kleczka (D-Wis.)	Y	Y	Y	Y
Kolbe (R-Ariz.)	N	N	Y	N
Kolter (D-Pa.)	Y	Y	Y	Y
Konnyu (R-Calif.)	N	Y	Y	N
Kostmayer (D-Pa.)	Y	Y	Y	Y
Kyl (R-Ariz.)	N	N	Y	N
LaFalce (D-N.Y.)	Y	Y	Y	Y

	HR4264	HR4418	H162	H3
lif.)	N	Y	Y	Y
-Texas)	Y	Y	N	Y
hia)	N	Y	Y	Y
N.Y.)	Y	Y	Y	N
Mass.)	N	Y	Y	Y
riz.)	N	N	N	N
t-Tenn.)	N	Y	N	N
t-Texas)	N	Y	N	N
ish.)	Y	Y	Y	Y
-Ga.)	N	Y	N	N
clo.)	Y	Y	Y	Y
C.)	Y	Y	Y	Y
wo)	N	Y	N	N
a.)	Y	Y	*	Y
a.)	N	Y	N	N
Ga.)	N	Y	N	Y
Calif.)	N	Y	N	N
alif.)	Y	*	Y	Y
-N.J.)	Y	Y	Y	Y
.Y.)	N	Y	Y	Y
-Ohio)	Y	Y	Y	Y
Mich.)	Y	*	Y	Y
z.)	Y	Y	Y	Y
ich.)	N	Y	N	Y
-N.C.)	Y	Y	N	Y.
(R-Mich.)	N	Y	N	Y
inn.)	Y	*	Y	Y
-Ind.)	Y	Y	Y	Y
Mo.)	Y	Y	Y	Y
(R-Nev.)	N	Y	N	N
Pa.)	Y	Y	Y	Y
a.)	N	Y	N	N
Okla.)	Y	*	Y	Y
-Calif.)	N	Y	N	Y
inn.)	N	Y	N	N
Y.)	N	Y	Y	Y
a.)	Y	N	Y	Y
ia.)	N	Y	Y	Y
t-Kan.)	N	Y	N	N
Miss.)	N	Y	Y	Y
Mont.)	N	Y	Y	Y
exas)	Y	*	Y	Y
)	Y	Y	Y	Y
	N	Y	N	N
ich.)	N	Y	Y	Y
N.Y.)	N	Y	N	N
exas)	Y	Y	Y	Y

Mazzali (D-Ky.)	Y	Y	Y	Y
Meyers (R-Kan.)	N	N	Y	N
Mfume (D-Md.)	Y	Y	Y	Y
Mica (D-Fla.)	Y	Y	*	*
Michel (R-Ill.)	N	N	Y	N
Miller (R-Ohio)	Y	N	Y	N
Miller (D-Calif.)	Y	Y	Y	N
Miller (R-Wash.)	N	N	Y	N
Mineta (D-Calif.)	Y	Y	Y	N

Rangel (D-N.Y.)	Y	Y	Y	N
Ravenel (R-S.C.)	N	N	Y	Y
Ray (D-Ga.)	Y	N	Y	Y
Regula (R-Ohio)	Y	N	Y	N
Rhodes (R-Ariz.)	N	N	Y	N
Richardsan (D-N.M.)	Y	Y	Y	Y
Ridge (R-Pa.)	Y	N	Y	Y
Rinaldo (R-N.J.)	Y	Y	Y	Y
Ritter (R-Pa.)	Y	N	Y	Y

Smith (R-Neb.)	N	N	Y	Y
Snows (R-Maine)	Y	N	Y	Y
Solarz (D-N.Y.)	Y	Y	Y	Y
Solaman (R-N.Y.)	N	Y	Y	N
Spence (R-S.C.)	Y	N	*	*
Spratt (D-S.C.)	Y	Y	Y	Y
Staggers (D-Va.)	Y	Y	Y	Y
Stallings (D-Idaho)	Y	Y	Y	Y
Stangeland (R-Minn.)	N	*	Y	N

Wyden (D-Ore.)	Y	Y	Y	Y
Wylie (R-Ohio)	N	N	Y	N
Yates (D-Ill.)	Y	Y	Y	*
Yatron (D-Pa.)	Y	Y	Y	Y
Young (R-Fla.)	N	N	Y	N
Young (R-Alaska)	N	Y	Y	N

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	H3	H162	HR44
Ackerman (D-N.Y.)	Y	Y	
Akaka (D-Hawaii)	Y	Y	
Alexander (D-Ark.)	Y	Y	
Anderson (D-Calif.)	Y	Y	
Andrews (D-Tex.)	Y	Y	
Annuzio (D-Ill.)	*	Y	
Anthany (D-Ark.)	Y	Y	
Applegate (D-Ohio)	Y	Y	
Archer (R-Tex.)	N	N	
Armey (R-Tex.)	N	N	
Aspin (D-Wis.)	Y	Y	
Atkins (D-Mass.)	Y	Y	
AuCoin (D-Dre.)	N	Y	
Badham (R-Calif.)	*	*	
Baker (R-La.)	N	N	
Ballenger (R-N.C.)	Y	N	
Barnard (D-Ga.)	Y	Y	
Bartlett (R-Tex.)	N	N	
Barton (R-Tex.)	N	N	
Bateman (R-Va.)	N	N	
Bates (D-Calif.)	Y	Y	
Beilenson (D-Calif.)	N	N	
Bennet (D-Fla.)	Y	Y	
Bentley (R-Md.)	Y	N	
Bereuter (R-Neb.)	Y	N	
Berman (D-Calif.)	Y	Y	
Bevill (D-Ala.)	Y	N	
Biaggi (D-N.Y.)	Y	*	
Bilbray (D-Nev.)	Y	Y	
Bilirakis (R-Fla.)	N	N	
Bliley (R-Va.)	N	*	
Boehlert (R-N.Y.)	Y	N	
Boggs (D-La.)	Y	Y	
Boland (D-Mass.)	Y	Y	
Bonior (D-Mich.)	Y	Y	
Bonker (D-Wash.)	Y	Y	
Borski (D-Pa.)	Y	Y	
Bosco (D-Calif.)	N	Y	
Boucher (D-Va.)	Y	Y	
Boutler (R-Tex.)	N	N	
Boxer (D-Calif.)	Y	Y	
Brennan (D-Maine)	Y	Y	
Brooks (D-Tex.)	Y	Y	
Broomfield (R-Mich.)	N	N	
Brown (D-Calif.)	Y	Y	Y	Y
Brown (R-Colo.)	Y	N	Y	N
Bruce (D-Ill.)	Y	Y	Y	Y
Bryant (D-Tex.)	Y	Y	Y	Y
Buechner (R-Mo.)	N	N	Y	N
Bunning (R-Ky.)	N	N	Y	N
Burton (R-Ind.)	N	N	Y	N
Bustamante (D-Tex.)	Y	*	Y	Y
Byron (D-Md.)	Y	Y	Y	Y
Dixon (D-Calif.)	Y	Y	Y	Y
Donnelly (D-Mass.)	Y	Y	Y	Y
Dorgan (D-N.D.)	Y	Y	Y	Y
Dornan (R-Calif.)	N	N	Y	N
Dowdy (D-Miss.)	Y	Y	Y	Y
Downey (D-N.Y.)	Y	Y	Y	Y
Dreier (R-Calif.)	N	N	Y	N
Duncan (R-Tenn.)	N	N	*	N
Durbin (D-Ill.)	Y	Y	Y	Y
Grant (D-Fla.)	Y	N	Y	Y
Gray (D-Ill.)	Y	Y	Y	Y
Gray (D-Pa.)	Y	Y	Y	Y
Green (R-N.Y.)	N	Y	Y	Y
Gregg (R-N.H.)	N	N	Y	N
Guarini (D-N.J.)	Y	Y	Y	Y
Gunderson (R-Wis.)	N	N	Y	N
Hall (D-Texas)	Y	N	Y	N
Hall (D-Ohio)	Y	Y	Y	Y
Kennelly (D-Conn.)	Y	Y	Y	Y
Kildee (D-Mich.)	Y	Y	Y	Y
Kleczka (D-Wis.)	Y	Y	Y	Y
Kolbe (R-Ariz.)	N	N	Y	N
Kolter (D-Pa.)	Y	Y	Y	Y
Konnyu (R-Calif.)	N	Y	Y	N
Kostmayer (D-Pa.)	Y	Y	Y	Y
Kyl (R-Ariz.)	N	N	Y	N
LaFalce (D-N.Y.)	Y	Y	Y	Y

	H3	H162	HR4418	HR4264
Lagomarsino (R-Calif.)	N	N	Y	N
Lancaster (D-N.C.)	Y	N	Y	Y
Lantos (D-Calif.)	Y	Y	Y	Y
Latta (R-Dhia)	N	N	Y	N
Leach (R-Iowa)	N	N	Y	N
Leath (D-Texas)	Y	*	Y	Y
Lehman (D-Calif.)	Y	Y	Y	Y
Lehman (D-Fla.)	Y	Y	Y	Y
Leland (D-Texas)	Y	Y	Y	N
Lent (R-N.Y.)	N	*	Y	N
Levin (D-Mich.)	Y	Y	Y	Y
Levine (D-Calif.)	Y	Y	Y	Y
Lewis (R-Calif.)	N	N	*	N
Lewis (D-Ga.)	Y	Y	Y	N
Lewis (R-Fla.)	N	N	Y	N
Lightfoot (R-Iowa)	N	N	Y	N
Lipinski (D-Ill.)	Y	Y	Y	Y
Livingstan (R-La.)	*	*	Y	N
Llayd (D-Tenn.)	Y	Y	Y	Y
Lott (R-Miss.)	N	N	Y	Y
Lawery (R-Calif.)	N	N	Y	N
Lawry (D-Wash.)	N	Y	Y	Y
Lujan (R-N.M.)	N	Y	Y	Y
Luken (D-Dhia)	Y	N	Y	Y
Lukens (R-Dhia)	N	N	N	N
Lungren (R-Calif.)	N	N	*	N
McCandless (R-Calif.)	N	N	Y	N
McClaskey (D-Ind.)	Y	Y	Y	Y
McCallum (R-Fla.)	N	N	Y	N
McCurdy (D-Dkla.)	Y	Y	Y	Y
McDade (R-Pa.)	Y	Y	Y	N
McEwen (R-Dhia)	N	N	Y	N
McGrath (R-N.Y.)	N	N	Y	N
McHugh (D-N.Y.)	Y	Y	Y	Y
McMillan (R-N.C.)	N	N	Y	Y
McMillen (D-Md.)	Y	Y	Y	N
Mack (R-Fla.)	N	N	*	N
MacKay (D-Fla.)	Y	N	*	Y
Madigan (R-Ill.)	N	N	Y	N
Mantan (D-N.Y.)	Y	Y	Y	Y
Markey (D-Mass.)	Y	Y	Y	Y
Marlenee (R-Mant.)	N	N	Y	Y
Martin (R-N.Y.)	N	*	Y	N
Martin (R-Ill.)	N	N	Y	N
Martinez (D-Calif.)	Y	Y	Y	Y
Matsui (D-Calif.)	Y	Y	Y	Y
Mavroules (D-Mass.)	Y	Y	Y	Y
Mazzali (D-Ky.)	Y	Y	Y	Y
Meyers (R-Kan.)	N	N	Y	N
Mfume (D-Md.)	Y	Y	Y	Y
Mico (D-Fla.)	Y	Y	*	*
Michel (R-Ill.)	N	N	Y	N
Miller (R-Dhia)	Y	N	Y	N
Miller (D-Calif.)	Y	Y	Y	N
Miller (R-Wash.)	N	N	Y	N
Mineta (D-Calif.)	Y	Y	Y	N
Mookley (D-Mass.)	Y	Y	Y	Y
Molinari (R-N.Y.)	N	Y	Y	N
Mallahan (D-Va.)	Y	Y	Y	Y
Montgomery (D-Miss.)	Y	N	Y	Y
Moody (D-Wis.)	Y	Y	*	N
Moorhead (R-Calif.)	N	N	Y	N
Marella (R-Md.)	N	N	Y	Y
Morrisan (D-Cann.)	Y	Y	Y	Y
Marrisan (R-Wash.)	N	N	Y	Y
Mrazek (D-N.Y.)	N	Y	Y	Y
Murphy (D-Pa.)	Y	Y	Y	Y
Murtha (D-Pa.)	Y	Y	Y	Y
Myers (R-Ind.)	N	N	Y	N
Nagle (D-Iawa)	Y	Y	Y	Y
Natcher (D-Ky)	Y	Y	Y	Y
Neal (D-N.C.)	Y	N	Y	Y
Nelson (D-Fla.)	Y	N	Y	Y
Nichols (D-Ala.)	Y	*	Y	Y
Nielsan (R-Utah)	N	N	*	N
Nawak (D-N.Y.)	Y	Y	Y	Y
Dakar (D-Ohia)	Y	Y	Y	Y
Dberstar (D-Minn.)	Y	Y	Y	N
Dbey (D-Wis.)	Y	Y	Y	Y
Dlin (D-Va.)	Y	Y	Y	Y
Drtiz (D-Texas)	Y	N	Y	Y
Dwens (D-N.Y.)	Y	Y	Y	N
Dwens (D-Utah)	Y	Y	Y	Y
Dxley (R-Dhia)	N	N	Y	N
Packard (R-Calif.)	N	N	Y	N
Panetta (D-Calif.)	N	N	Y	Y
Parris (R-Va.)	N	N	Y	N
Pashayan (R-Calif.)	N	Y	Y	N
Pattersan (D-S.C.)	Y	N	Y	Y
Pease (D-Dhia)	Y	Y	Y	Y
Pelasi (D-Calif.)	Y	Y	Y	N
Penny (D-Minn.)	Y	Y	Y	Y
Pepper (D-Fla.)	Y	*	Y	Y
Perkins (D-Ky.)	Y	Y	Y	Y
Petri (R-Wis.)	N	Y	Y	N
Pickett (D-Va.)	Y	N	Y	Y
Pickle (D-Texas)	Y	N	Y	Y
Parter (R-Ill.)	N	N	Y	Y
Price (D-N.C.)	Y	Y	Y	Y
Price (D-Ill.)	Y	Y	Y	Y
Pursell (R-Mich.)	Y	N	Y	Y
Quillen (R-Tenn.)	Y	*	Y	N
Rahall (D-Va.)	Y	Y	Y	Y
Rangel (D-N.Y.)	Y	Y	Y	N
Ravenel (R-S.C.)	N	N	Y	Y
Ray (D-Ga.)	Y	N	Y	Y
Regula (R-Dhia)	Y	N	Y	N
Rhodes (R-Ariz.)	N	N	Y	N
Richardsan (D-N.M.)	Y	Y	Y	Y
Ridge (R-Pa.)	Y	N	Y	Y
Rinaldo (R-N.J.)	Y	Y	Y	Y
Ritter (R-Pa.)	Y	N	Y	Y
Roberts (R-Kan.)	N	N	Y	N
Robinsan (D-Ark.)	Y	Y	Y	Y
Rodina (D-N.J.)	Y	Y	Y	Y
Roe (D-N.J.)	Y	Y	Y	Y
Rogers (R-Ky.)	Y	N	Y	N
Rose (D-N.C.)	Y	N	Y	Y
Rastenkowski (D-Ill.)	Y	Y	Y	Y
Rath (R-Wis.)	N	N	Y	N
Raukema (R-N.J.)	Y	Y	Y	Y
Rowland (D-Ga.)	Y	N	Y	Y
Rawland (R-Conn.)	Y	N	Y	N
Raybal (D-Calif.)	Y	Y	Y	Y
Russo (D-Ill.)	Y	Y	Y	Y
Saba (D-Minn.)	Y	Y	Y	Y
Saiki (R-Hawaii)	N	N	Y	Y
St Germain (D-R.I.)	Y	Y	Y	Y
Savage (D-Ill.)	Y	Y	Y	N
Sawyer (D-Dhia)	Y	Y	Y	Y
Saxton (R-N.J.)	N	Y	Y	N
Schaefer (R-Cala.)	N	N	Y	N
Scheuer (D-N.Y.)	Y	*	Y	N
Schneider (R-R.I.)	Y	Y	Y	Y
Schroeder (D-Cala.)	*	Y	Y	N
Schuette (R-Mich.)	Y	N	Y	N
Schulze (R-Pa.)	Y	N	Y	N
Schumer (D-N.Y.)	Y	Y	Y	Y
Sensenbrenner (R-Wis.)	N	N	Y	N
Sharp (D-Ind.)	Y	Y	Y	Y
Shaw (R-Fla.)	N	N	Y	N
Shays (R-Conn.)	N	Y	Y	N
Shumway (R-Calif.)	N	N	Y	N
Shuster (R-Pa.)	Y	N	Y	N
Sikorski (D-Minn.)	Y	Y	Y	N
Sisiski (D-Va.)	Y	Y	Y	Y
Skaggs (D-Cala.)	Y	Y	Y	Y
Skeen (R-N.M.)	N	N	Y	N
Skeltan (D-Ma.)	Y	N	Y	Y
Slattery (D-Kan.)	Y	N	Y	Y
Slaughter (R-Va.)	N	N	Y	Y
Slaughter (D-N.Y.)	Y	Y	Y	Y
Smith (R-N.J.)	Y	Y	Y	Y
Smith, D. (R-Dre.)	N	N	Y	N
Smith (R-Texas)	N	N	Y	N
Smith (D-Fla.)	Y	Y	Y	Y
Smith (D-Iawa)	Y	Y	Y	Y
Smith (R-N.H.)	N	N	Y	Y
Smith, R. (R-Dre.)	N	N	Y	Y
Smith (R-Neb.)	N	N	Y	Y
Snaws (R-Maine)	Y	N	Y	Y
Solarz (D-N.Y.)	Y	Y	Y	Y
Salaman (R-N.Y.)	N	Y	Y	N
Spence (R-S.C.)	Y	N	*	*
Spratt (D-S.C.)	Y	Y	Y	Y
Staggers (D-Va.)	Y	Y	Y	Y
Stallings (D-Idaha)	Y	Y	Y	Y
Stangeland (R-Minn.)	N	*	Y	N
Stark (D-Calif.)	Y	Y	Y	N
Stenhalm (D-Texas)	Y	N	Y	Y
Stakes (D-Dhia)	Y	Y	Y	N
Stratton (D-N.Y.)	N	Y	Y	Y
Studds (D-Mass.)	Y	Y	Y	N
Stump (R-Ariz.)	N	N	N	N
Sundquist (R-Tenn.)	N	N	Y	N
Sweeney (R-Texas)	N	N	Y	N
Swift (D-Wash.)	Y	Y	Y	Y
Swindall (R-Ga.)	N	N	Y	N
Synar (D-Dkla.)	Y	Y	Y	Y
Tallan (D-S.C.)	Y	Y	Y	Y
Tauke (R-Iowa)	N	N	Y	N
Tauzin (D-La.)	Y	*	Y	Y
Taylor (R-Ma.)	N	N	Y	N
Thamas (D-Ga.)	Y	N	Y	Y
Thomas (R-Calif.)	N	N	Y	N
Torres (D-Calif.)	Y	Y	*	Y
Tarricelli (D-N.J.)	Y	Y	Y	Y
Tawns (D-N.Y.)	Y	Y	Y	N
Traficant (D-Dhia)	Y	Y	Y	Y
Traxler (D-Mich.)	Y	*	Y	Y
Udall (D-Ariz.)	Y	Y	Y	Y
Upton (R-Mich.)	Y	N	Y	N
Valentine (D-N.C.)	Y.	N	Y	Y
Vander Jagt (R-Mich.)	Y	N	Y	N
Vento (D-Minn.)	Y	*	Y	Y
Visclasky (D-Ind.)	Y	Y	Y	Y
Valkmer (D-Ma.)	Y	Y	Y	Y
Vucanavich (R-Nev.)	N	N	Y	N
Walgren (D-Pa.)	Y	Y	Y	Y
Walker (R-Pa.)	N	N	Y	N
Watkins (D-Dkla.)	Y	*	Y	Y
Waxman (D-Calif.)	Y	Y	Y	N
Weber (R-Minn.)	N	N	Y	N
Weiss (D-N.Y.)	Y	Y	Y	N
Weldan (R-Pa.)	Y	N	Y	Y
Wheat (D-Mo.)	Y	Y	Y	N
Whittaker (R-Kan.)	N	N	Y	N
Whitten (D-Miss.)	Y	Y	Y	Y
Williams (D-Mant.)	Y	Y	Y	N
Wilson (D-Texas)	Y	Y	*	Y
Wise (D-Va.)	Y	Y	Y	Y
Walf (R-Va.)	N	N	Y	N
Walpe (D-Mich.)	Y	Y	Y	Y
Wartley (R-N.Y.)	N	N	Y	N
Wright (D-Texas)	Y	Y	Y	Y
Wyden (D-Dre.)	Y	Y	Y	Y
Wylie (R-Dhia)	N	N	Y	N
Yates (D-Ill.)	Y	Y	Y	*
Yatron (D-Pa.)	Y	Y	Y	Y
Young (R-Fla.)	N	N	Y	N
Young (R-Alaska)	N	Y	Y	N

Finding a Place For Hazardous Waste

Tighter federal rules for landfills encourage the search for technological solutions

BY SUSAN GILBERT

ALL KINDS of companies, from oil refineries to chemical plants, generate hazardous waste. Even relatively small businesses, such as the neighborhood dry cleaners, also produce potentially dangerous substances. All these companies face a major problem: how to dispose of their pollutants as the federal government intensifies restrictions on what can be buried in landfills.

The search for solutions has created a burgeoning industry, generally estimated at $13 billion to $20 billion in revenues a year, to deal with the more than 250 million tons of hazardous waste created each year. Services provided by companies in this industry include identifying a client's hazardous wastes, reducing the toxicity of those wastes, disposing of them, and advising clients on ways to stem the flow.

As the government slowly strengthens laws governing hazardous-waste disposal, a number of specialized companies are applying technology to the problem. Landfills remain the ultimate destination for most toxic waste, but more and more waste is treated before burial. The percentage of untreated waste has declined from 80 percent six years ago to 20 percent today, according to the National Solid Waste Management Association, a trade group.

Government regulations are constantly adding to the list of substances that can no longer be dumped untreated into a landfill. The roster currently includes pesticides, phenols, all sorts of acids, arsenic, dioxin, various solvents, and toxic metals such as mercury, lead, and zinc. As new substances join the list, treatment technologies must be developed to deal with them.

Analysts say these technologies, which range from fortifying pollution-eating bacteria to freeze-drying polluted water, are still too new to determine which ones will come out on top. The bottom line is that any technology that can reduce the incredible volume of hazardous waste being spewed into the environment will offer a competitive edge. Any technology that works represents a vast improvement over simple burial or burning.

Analysts divide the hazardous-waste management industry into four market segments: treating and disposing of waste, cleaning up polluted areas, helping companies deal with their waste themselves, and testing to determine pollution levels.

Currently, the companies that specialize in treating and disposing of waste form by far the biggest part of the industry. Chemical Waste Management Inc. dominates the business with 8,000 clients and 23 of the 60 commercial hazardous-waste landfills in the United States. Waste Management Inc., a general-garbage disposal company, owns 82 percent of Chemical Waste Management, and analysts see the company's nationwide network of landfills as a tremendous asset. Even as treatment options grow, the waste must still go somewhere. Recognizing that pure landfill operations may be in trouble, however, the company has built facilities to treat waste before it gets buried in eight of its landfills.

Chemical Waste Management's chief competition is Rollins Environmental Services Inc., which operates four of the country's 14 commercial hazardous-waste incinerators. Incinerators are the chief alternative to landfills, because they destroy as much as 75 percent of the waste fed into them. Only 1 percent of the hazardous waste in the United States now gets incinerated, but that percentage is expected to skyrocket as landfills start to fill up.

Rollins will ride any upswing in incineration, but burning hazardous waste has several limitations. Incineration eliminates only organic wastes—solvents, pesticides, paints, and other chemicals—and these substances make up only about half of all hazardous wastes. Incinerators also emit air pollution, and local residents often attempt to block permits for new facilities.

DAVID M. DOODY/UNIPHOTO

Ironically, manufacturing changes aimed at curbing waste production have created problems for incinerators. These measures have increased the concentration of toxic materials in waste, making it more difficult to burn cleanly and increasing the concentration of metals—inorganic wastes that cannot be burned and are hard to break down chemically. To address this problem, Rollins is building a new kind of incinerator in Texas that not only burns dense concentrations of organic wastes, but also handles toxic metals. The incinerator, called a rotary reactor, encapsulates these metals in a glass-like coating to keep them from leaching out when the residue from incineration is buried in a landfill.

The third major player in the hazardous-waste disposal business is Cecos International, which is a subsidiary of Browning-Ferris Industries Inc. Cecos operates eight hazardous-waste landfills and has applied for a permit to build an incinerator.

However, commercial operations that deal with hazardous waste compete not only with each other, but also with the companies that produce the waste. Many businesses prefer to dispose of their wastes themselves, and commercial operations handle only about 4 percent of all hazardous waste created. Small-scale waste generators such as dry cleaners and lawn-care outfits have no choice but to use commercial disposers, but soaring costs mean that large companies often find it cheaper to do the job themselves. Landfill fees have ballooned from $10 a ton five years ago to about $240 a ton today, according to the Environmental Protection Agency, and incineration fees have also risen dramatically. Exxon and 3M, for example, acknowledge that they save money by taking care of much of their own waste, but they won't say exactly how much.

Many waste producers are also turning to recycling to keep costs down. 3M estimates that its 13-year-old waste-reduction program, which includes recycling and conservation, has saved the corporation $400 million. A similar program has saved Dow Chemical more than $5 million since 1986.

In 1986, in an attempt to cash in on this trend, Chemical Waste Management got into the recycling business by acquiring Oil and Solvent Process Co. (OSCO) of Azusa, Calif. OSCO recovers oils and solvents from industrial wastes and refines them for sale as fuel.

Manufacturers retain legal responsibility for their waste even after they hand it over to a waste-management firm, but company executives and analysts disagree about the effects of this liability. Many companies say they dispose of their own waste to make sure the job is done right. "The real reason we have our own incinerators is to make sure our waste is disposed of properly," says a 3M spokesman.

But some experts say that continuing liability prompts companies to hire very reputable, highly experienced firms to handle the problem. "As the liability stakes rise, there will be a shift to commercial handling of hazardous waste,"

THE CLEANUP HITTERS

COMPANY	1986 REVENUE/ EARNINGS	1987 REVENUE/ EARNINGS	SPECIALTY
Chemical Waste Management 3003 Butterfield Rd. Oak Braak, IL 60521 (312) 218-1500	$418 million/ $52.2 millian	$559 million/ $87 million	Owns 23 landfills, eight with treotment facilities; alsa daes waste-reduction cansulting and recycling. Performs aggressive research in many oreas of waste treatment.
Rollins Enviranmental Services 1 Rallins Plaza Wilmingtan, DE 19899 (302) 479-2700	$136.9 million/ $18.7 million	$173.6 million/ $28.4 million	Owns four incinerators and is builidng a fifth.
Brawning-Ferris Industries 14701 St. Mary's Lane Houstan, TX 77079 (713) 870-8100	$1.3 billian/ $137 millian	$1.6 billion/ $172 million	Disposing of nonhazardaus waste forms 95 percent of its business. Owns Cecos Internationol of Buffalo, N.Y., which runs eight hazardous-waste londfills, two injection wells, and three wastewoter-treatment facilities.
Enseco 205 Alewife Brook Pkwy. Cambridge, MA 02138 (617) 661-3111	$29.5 million/ $710,000	$37.5 million/ $4.5 million	The internatianal leader in testing and laboratory analysis to detect hozardous substonces in soil and water.
Canonie Environmental Services 800 Cononie Dr. Porter, IN 46304 (219) 926-8651	$22.3 million/ $2 million	$30 million/ $3.9 million	On-site cleonup of contaminated soil and groundwater.
Groundwater Technalagy 220 Norwood Park S. Norwood, MA 02062 (617) 769-7600	$19 millian/ $1.9 million	$37.2 million/ $3.4 million	On-site cleonup of contominated soil, woter, and oir.
Emcon Associates 1921 Ringwood Ave. San Jose, CA 95131 (408) 275-1444	$19 million/ $1.2 million	$24.3 million/ $3 million	Designs waste-disposal facilities, cleans up hazardaus-waste sites, and performs testing and laboratory analysis of contominated oreas.
Environmental Treatment & Technology 16406 U.S. Route 224 East Findlay, OH 45840 (419) 423-3526	$101.4 million/ $2.8 million	$137 millian/ $2.4 million	Cleonup of hozardous-waste sites.

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

predicts Marc Sulam, an analyst who follows the industry for Kidder, Peabody & Company in New York.

Treatment and disposal may be the biggest sector of the industry, but cleaning up polluted sites has gotten the most publicity and is expected to grow the fastest. "Private industry will spend multiples of what the federal government spends on Superfund cleanups in order to avoid being sued," says Sulam. The 1980 Superfund Act makes companies liable for the costs of dealing with pollutants they dumped and later abandoned. Cleaning up these contaminated sites will be one of the fastest growing areas of the business—and the one in which new technology will probably play the biggest role.

Cleanup companies use various kinds of portable equipment to partially or fully break down hazardous chemicals in soil or water. Hazardous matter that cannot be fully eliminated at the site is generally shipped to commercial landfills or incinerators.

Various companies are developing processes that use bacteria and other microscopic organisms to digest—and thereby completely eliminate—hazardous pollutants. Such microbes are being used in sewage treatment to scavenge toxic metals and other chemicals.

Groundwater Technology fortifies pollution-eating bacteria to speed the natural cleanup process. This technique, called enhanced natural degradation, pumps the groundwater from a waste site and adds oxygen and nutrients to encourage the growth of natu-

EPA RULES RUN THE INDUSTRY

The industry of managing hazardous waste has developed to satisfy government regulations aimed at keeping the environment free of contaminants.

Two key laws set guidelines for the industry. The Resource Conservation and Recovery Act (RCRA), passed in 1976 and amended in 1984, aims "to minimize the land disposal of hazardous waste," says J. Winston Porter, assistant administrator of solid waste and emergency response for the Environmental Protection Agency, which is responsible for supervising hazardous-waste management.

This law regulates the disposal of about 500 chemicals, mandating treatment for sludges, wastewater, and other industrial by-products containing those chemicals—usually by burning or chemical processes. The residues must be buried in federally regulated landfills designed to keep hazardous waste from contaminating the environment. The law also requires businesses to devise plans for reducing the amount of waste they generate, a requirement that has created consulting opportunities for companies with expertise in recycling and conservation.

The Superfund Act of 1980 also has a profound effect on the waste-management industry. This bill calls for the cleanup of about 20,000 abandoned sites where companies dumped their pollutants before the RCRA was passed. Congress toughened the Superfund Act in 1986 by allocating $8.5 billion for cleaning up these sites through 1991. Most of this money will go to companies that specialize in decontaminating soil and water.

Another aspect of the 1986 Superfund amendment should spur demand for technologies that reduce the volume of hazardous waste, including recycling and incineration. The amendment gives states until 1990 to prove that they have the capacity to dispose of all the hazardous waste generated within their borders for the next 20 years. States that fail to meet this deadline will be ineligible for federal Superfund cleanup money.

TREATING HAZARDOUS WASTE

Almost all hazardous waste winds up in landfills, and federal regulations require that such waste be treated before burial to reduce the waste's toxicity by 99.99 percent. The primary types of treatments are each suited for different kinds of hazardous waste.

Incineration. Organic materials, which include industrial solvents, pesticides, and paints, can be almost completely destroyed in incinerators. Burning these wastes reduces their volume by three-fourths, leaving an ash residue that must be deposited in a hazardous-waste landfill.

Chemical treatment. An alternative to burning organic wastes is to break them down chemically into harmless elements such as oxygen, hydrogen, and carbon. Though not necessarily more effective than incineration, chemical treatment is used when incinerators are not available—often, for example, at landfill sites.

Stabilization. Neither incineration nor chemical treatment breaks down toxic metals, so disposers concentrate on keeping such metals separate from the environment—by sealing the metals in a hard material such as cement, or making the metals themselves so hard that, once buried, they will not leach into the soil or water. Unfortunately, stabilization usually increases the volume of the waste.

Microbe treatment. A few kinds of hazardous waste, including PCBs, mercury, and lead, can be digested by bacteria and other microbes and thereby reduced to harmless elements. Because biological treatment is the most expensive hazardous-waste solution, it's considered a last-ditch effort, says Suellen Pirages of the National Solid Waste Management Association.

Deep-well injection. Current federal regulations do not require treatment of highly diluted wastes—water that contains less than 2 percent hazardous materials. The standard disposal method for such wastewater is to mechanically inject it into pockets of rock thousands of feet underground. Much wastewater is a by-product of oil processing, and petroleum companies typically put it back in the wells from which they pumped the oil. But the days of untreated wastewater may be numbered. Last August, as part of the Resource Conservation and Recovery Act, the EPA was scheduled to decide whether deep-well injection of wastewater can continue without regulation.

rally occurring bacteria that eat such substances as benzine, PCBs, and chlorinated solvents. (Benzine is a carcinogen found in gasoline; PCBs—polychlorinated biphenyls—insulate electrical equipment; chlorinated solvents are used to clean metals.) The fortified groundwater goes back into the soil, where the microbes attack the pollutants. Groundwater Technology says its technique cuts the time needed to biodegrade chemicals from decades to about nine months. The company is already using its system at a number of Superfund cleanup sites.

Other companies working on bacteria-powered techniques for dealing with hazardous waste include Du Pont Biosystems; Detox Industries of Sugar Land, Tex; and Ecova, based in Redmond, Wash.

Although microbiological approaches have been effective in some cases, the wider application of this technology will depend on successful tinkering with microbes' genes to create new strains of organisms that can digest a wider variety of pollutants. Privately held Genencor of South San Francisco is using genetic engineering to develop both microbes and enzymes to deal with various pesticides, which are difficult to degrade by other methods.

Chemical Waste Management is also active in the cleanup business, leading the development of a new technology called freeze crystallization. This technique purifies water by freezing it, forming ice crystals of clean water that can be separated from the contaminants. Freeze crystallization requires just 14 percent of the energy needed for existing water treatments, which boil out the water. Freeze crystallization also doesn't cause air pollution.

Canonie Environmental Services Corp., another cleanup leader, has developed a proprietary technology to separate liquid pollutants from soil. The company's "low-temperature thermal-aeration soil-remediation process" cooks tainted soil in a giant oven, converting liquids to gas. Pollutants are filtered from the gas as it leaves the oven. Canonie then either incinerates the particles or buries them in landfills, and returns the clean soil to the ground. Eighty percent of the company's business involves Superfund sites, with clients such as General Electric, Xerox, and Fairchild.

Another leader in hazardous-waste remediation, Environmental Treatment and Technology Corp., uses a mobile incinerator to burn PCBs at the site in question. This eliminates the need to transport chemicals elsewhere for treatment and disposal.

Because the vast majority of hazardous wastes are handled by the companies that produce them, a supporting industry of engineering and consulting firms has developed to help them do it. Many of these consultants also design landfills and incinerators.

Pittsburgh-based NUS Corp., for example, constructs landfills at hazardous-waste sites, and also designs and builds incinerators. Emcon Associates, which went public last year, built its reputation on designing landfills and incinerators, and recently branched out into the cleanup end of the business.

Landfill leader Chemical Waste Management is also moving into the consulting business. Last year, the firm started a service to advise clients on ways to minimize the amount of pollutants they create as they go about their business.

The first step in any hazardous-waste-management project is determining the magnitude of the problem, and some companies specialize in testing soil and water for toxins. The precise danger posed to people, animals, or plants also must be determined.

Analysts consistently praise Enseco Inc. for the quality of its management and services. The company works mainly for the Environmental Protection Agency, identifying and tracking the movement of pollutants at Superfund sites, but also does significant business with engineering firms that design landfills and incinerators. In addition, Enseco advises clients on how to deal with the complex maze of federal regu-

THE CRISIS OF INFECTIOUS WASTE

For the past two summers, New York and New Jersey were forced to close miles of beaches when used hypodermic needles and other medical refuse washed ashore. Some of the waste was infected with the AIDS and hepatitis-B viruses.

The problem is not confined to a few beaches. Many experts see a crisis in infectious-waste disposal. Nearly 500,000 tons of such wastes are generated each year, according to the National Solid Waste Management Association. The volume of infectious waste—needles, syringes, gauze, dressing gowns, and anything else that has come in contact with a patient—is increasing dramatically. But the technology and services available for safely disposing of these wastes are too primitive to handle the burden.

Even though infectious waste poses a potential health hazard, the federal government has no plans to regulate its disposal. However, 31 states now have laws requiring hospitals to disinfect such waste before they bury it in landfills. Disinfection involves either steam cleaning in an autoclave, or incineration.

Both methods have severe limitations. Autoclaving does not completely sterilize the waste, nor does it compress it or change its appearance; autoclaved waste is visually indistinguishable from unprocessed waste. And many incinerators cannot burn plastic materials, which are increasingly common in medicine, without creating unlawfully high levels of air pollution.

Two small companies are aggressively working on solutions. Medical Safetec Inc. has invented machines that grind up infectious materials and disinfect them with chlorine. The company sells small models to hospitals and has a larger model in its treatment plant in Indianapolis. A second plant is under construction in Waterbury, Conn.

The other innovator is Miami-based MedX, which was bought last year by Attwoods PLC, a British waste-management company. MedX president Carlos Campos says Attwoods is "pumping millions [of dollars] into research and development," including work on an incinerator that can burn plastics without creating excess air pollution. MedX is expanding its infectious-waste disposal service from Florida throughout the Southeast.

Vishnu Swarup, first vice president of research for Prudential-Bache Securities in New York, sees infectious-waste disposal as a relatively small market within the hazardous-waste management industry. But he predicts growth of between $200 million and $300 million a year. "The technology available today is the major obstacle to growth," says Campos. "The industry is still in diapers."

lations governing hazardous waste.

Effective technology is vital for successfully managing hazardous waste, but other factors also come into play. To a great extent, the hazardous-waste management industry is ruled by government regulations (see "EPA Rules Run the Industry," p. 28). Companies that generate waste don't want to spend any more to get rid of it than they have to, so waste-management companies must constantly monitor EPA regulations to keep costs down. The best techniques are considered expensive overkill if they go beyond what government standards require.

Freeze crystallization is a case in point. "Freeze crystallization probably could come on line quickly," says Suellen Pirages, managing director for environmental policy for the National Solid Waste Management Association. "But there are uncertainties about its applications because there are uncertainties about how much waste minimization the federal government will require in the future."

Current EPA rules give the edge to those companies that develop the best and cheapest technology to reduce the bulk of waste the agency has tagged as hazardous, thereby minimizing the amount that has to be buried in expensive, heavily regulated landfills. That could mean trouble for landfill companies such as market-leader Chemical Waste Management. But landfills will remain the final resting place for most types of hazardous waste, and Chemical Waste Management has already begun aggressive diversification into other aspects of its industry.

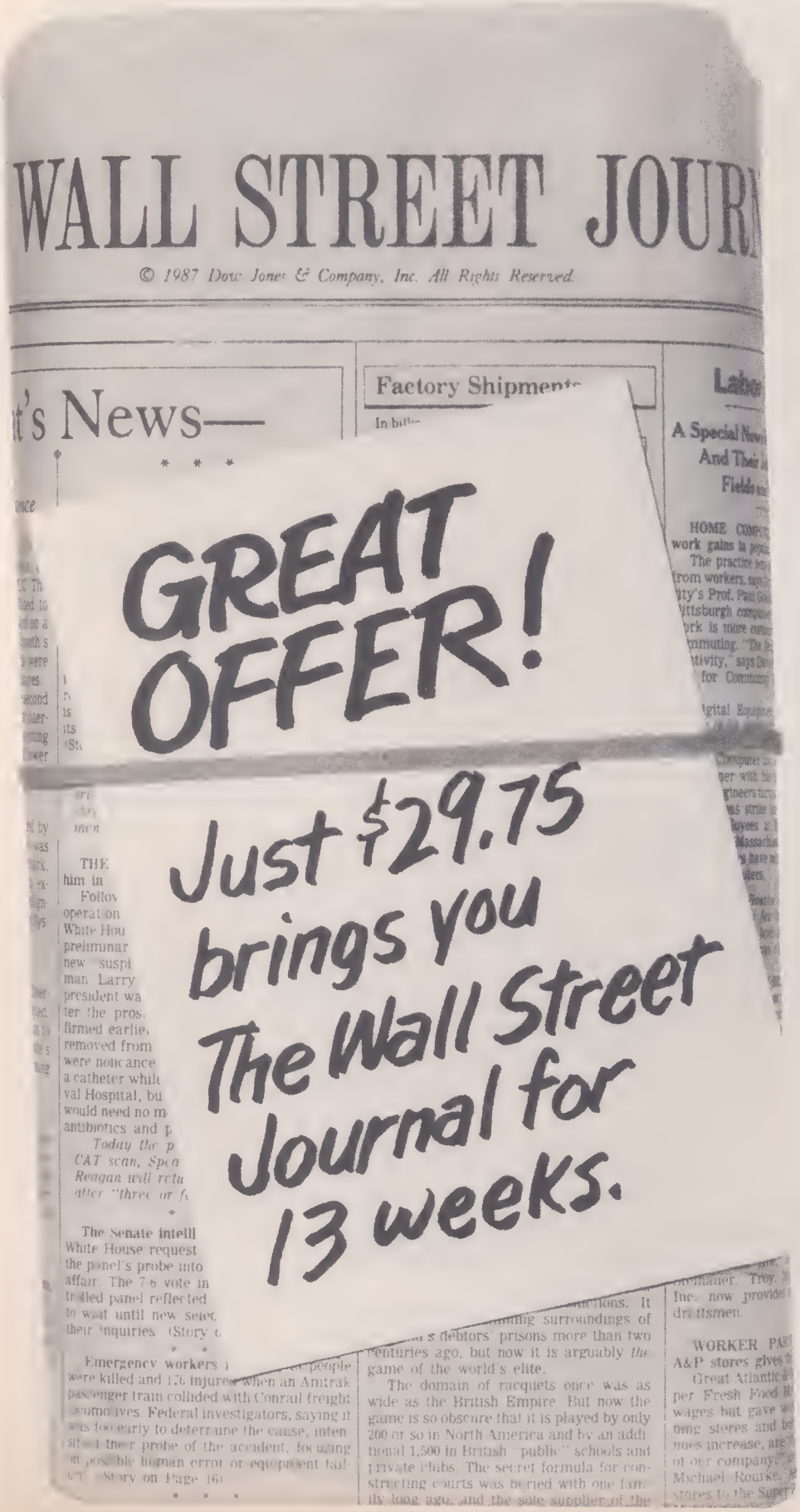
HOLT CONFER/UNIPHOTO

Cleaning up polluted sites should be the industry's fastest growing segment. ■

Perhaps the biggest danger facing companies comes after they've landed contract for a cleanup or disposal job. Along with their clients, commercial waste-management firms may also be held liable for any environmental damage caused by the substances they treat and bury. In April 1985, for example, Waste Management was fined $2.5 million for illegally dumping toxic chemicals in Ohio. Just last March, a fire broke out in Enseco's New Jersey laboratory, and local residents are now suing the company for contamination of the environment.

Not surprisingly, the advent of big-ticket environmental-damage lawsuits has led many insurance companies to stop writing liability policies for hazardous waste, or at least raise premiums and limit coverage. To cope, some hazardous-waste producers have created their own insurance carriers. For example, in June 1986, 17 small to medium-sized chemical companies banded together to form their own hazardous-waste-insurance company. ■

Susan Gilbert works as an associate editor for the New York Times' Good Health *magazine.*



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Expert Systems And The Law

Federal regulations and potential litigation pose dangers to a budding business

BY EDWARD WARNER

THE STOCK MARKET crash of 1987 revealed the darker side of computer automation. According to a government commission, the October free-fall was caused partly by computerized program trading, in which brokers' computer programs constantly compare the difference between the price of commodities futures and stocks. These price differences can change so fast that only computers can react quickly enough to take advantage of them. When stock prices started their dive, however, the system began feeding on itself, spinning the market out of human control and approaching what the chairman of the New York Stock Exchange later called a "meltdown."

The brokers of Black Monday readily delegated those buy/sell decisions to a computer program, but society at large is uneasy about using computers to make, or even give advice about, high-risk decisions. Nonetheless, software is becoming available which can do just that. These programs, called "expert systems," contain the knowledge of experts in a field and the logical rules those experts follow to solve a problem. Expert systems can advise a doctor on which medicine to prescribe for a patient's symptoms, tell an auditor how tax law might apply to a budgetary line-item, or decide in seconds whether a radar blip is an enemy rocket or a meteor—a task they will tackle for the Star Wars program.

No one questions the utility of spreading expert knowledge, but what happens when an expert system makes a mistake? What will be the reaction when, for example, a glitch in the software causes a prescription program to specify the wrong medicine? Unlike program-trading software, which brokerage houses developed themselves, expert systems are being produced both for internal corporate use and for sale to third parties. Sales of expert systems leaves someone to blame, and some observers say the greatest obstacle to the spread of such systems is fear of litigation.

Nowhere is the concern over product liability stronger than among companies working on expert systems for medical applications, where malpractice suits already abound. "I know of interesting endeavors that never came to light because of liability problems," says Dr. Braxton Degarmo, owner of the Medical Software Consortium, a St. Louis supplier of medical software. Degarmo participated in a U.S. Army/NASA effort to develop an "intensive-care stretcher," an unmanned emergency room for use on space vehicles. The stretcher would have monitored patients' vital signs and its expert system would have responded to changes in their condition with treatments such as drug injections. A medical-products company, he recalls, was ready to produce the stretcher's hardware, but balked at getting involved with the software because of concerns about the potential for lawsuits.

Expert systems consultant Tom J. Schwartz also knows of a medical expert system that was stalled because of legal doubts. The system's producer "sank a couple of man-years [of development time] into it and, when they looked at the cost for liability insurance, they said 'no way'," recalls Schwartz.

Litigation worries, says Degarmo, are particularly strong at universities, which are among the centers of medical expert systems development. A case in point: the Caduceus medical expert system at Carnegie-Mellon University in Pittsburgh, 17 years in development and still awaiting commercialization.

Despite these fears, the Health Industry Manufacturers Association predicts that, in the next 10 years, the biggest changes in health care will come from software. Expert systems "still haven't reached the capacity in the health-care system that their potential would indicate," says association presi-

WARREN GEBERT

dent Frank E. Samuel, Jr.

Expert systems will also be widely used in the corporate sector. Boiler manufacturer Combustion Engineering of Stamford, Conn., for example, uses an expert system to collect the knowledge of its best designers, speeding the design process and easing the transition when designers leave the company (see "Success Story," September 1988). Coopers & Lybrand, the accounting firm, has a system that dispenses tax advice to its auditors, and Honeywell-Bull sales representatives use an expert system to configure customers' computers by simply entering the customers' needs. By one analyst's estimate, about half of the companies listed in the *Fortune* 500 are developing expert systems.

Expert systems will also be sold commercially. Louis Robinson, publisher of the *Spang Robinson Report on Artificial Intelligence* newsletter, believes expert systems will one day be so prevalent that computer companies will routinely include them with their hardware the way they bundle-in software today.

However, lawyers warn that before expert systems become commonplace they will probably become ensnared in the widening web of product-liability litigation. According to the Brookings Institution, the number of product-liability lawsuits increased eightfold from 1974 to 1986, when 13,595 such cases were filed. One reason is the increasing number of lawyers who specialize in computer-related issues, up from 100 in 1980 to 1,100 in 1985.

Mixing these numbers with a slug of hyperbole, consultant Schwartz warns,

"There's 200,000 lawyers out there waiting for an expert system to kill a little old lady—and they're going to sue everybody in sight."

Of course, a suit does not automatically mean a loss in court. "The likelihood is that there would be many suits, but few judgments" against expert systems, predicts Richard Neely, a judge in the West Virginia Supreme Court of Appeals and an expert on product liability. But no expert-system producer wants to be the first to be saddled with a hefty judgment, and all expert systems producers worry that everyone's insurance rates will soar after the the first company loses a suit. "A lot of people are waiting for that first test case," says Degarmo.

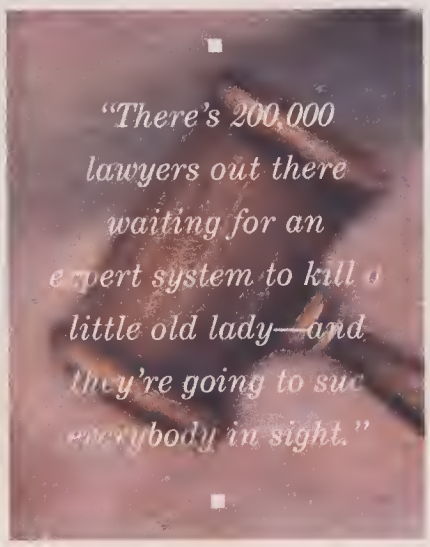
That first case is still over the horizon, so legal experts are looking closely at other lawsuits involving similar electronic products. In 1986, the U.S. Supreme Court upheld a $350,000 decision against Dun & Bradstreet, which provides credit information on U.S. companies, in a libel suit brought by a Vermont builder whose reputation was harmed by erroneous information from Dun & Bradstreet's computerized database. In 1982, NCR Corp. suffered a $2.3-million adverse judgment when a California court ruled that Glovatorium Inc., a dry cleaner, had been defrauded when NCR computers did not perform as promised.

Computer programs usually come with disclaimers that deny responsibility if the software fails to work as promised, but lawyers say these disavowals will offer little refuge when the summons hit the fan. Glovatorium's lawyer, Richard Perez, says he won his case despite several disclaimers in the NCR contract. One reason disclaimers carry little weight is that most software buyers never sign the enclosed license-agreement cards, notes Dan Shafer, editor of *Intelligent Systems Analyst*, a newsletter.

Eventually, something stronger than a disclaimer may be needed. In June, the House Energy and Commerce Committee approved a bill that would make companies liable if they fail to provide an adequate *warning* about hazards posed by their products.

Should an expert system user suffer damage, there will no shortage of parties to blame. Experts say possible lawsuit targets may extend from the user to the programmer, the supplier, and even the expert whose knowledge went into the program. In determining who is at fault, lawyers say a great deal will hinge on whether the system lets the user make the final decision. Pointing to a case where an automatic radiation-therapy machine inadvertently dispensed lethal overdoses (see "Federal Rules on Expert Systems," p. 35), Ed Miller, director of the Food and Drug Administration's compliance division for radiological products, says "the reason [the overdose] could occur was an attempt to make the system more user friendly." Unfortunately, expert systems may be needed in situations where equipment is more sophisticated than the typical technician.

Another indicator of blame, lawyers say, is whether the software is found to



have a "bug," or programming error. The prevalence of bugs, even in software involved in life-and-death decisions, is indicated by a recent FDA report that says bugs were behind 79 of the 84 computer-product recalls the agency initiated between 1983 and 1987. Judge Neely believes that bugs, not an expert's errors, pose the greatest potential for litigation against any type of software. Once customers come to expect a certain level of performance from any program—for instance, that it will add and subtract correctly—then a failure to meet that performance level "is like making a Buick with a wheel that falls off," he says.

No software company has yet lost a lawsuit brought over a bug, however. In 1986, Lotus Development Corp. was sued by a Florida construction company that claimed a bug in Lotus' 1-2-3 spreadsheet program caused the builder to overbid on a contract. Lotus blamed user error, and the case was settled out of court in Lotus' favor. But Boston-area lawyer Peter Marx, chairman of the New England Computer Law Forum, thinks the Lotus case is only the first in a wave of such suits. Marx warns that the courts will be increasingly inclined to hold programs to the strictest standard of liability.

Not only will expert systems need to be bug-free, they will also need to leaven their specialized knowledge with common sense. That may be very hard to do, says B. Chandrasekaran, director of the artificial intelligence research lab at Ohio State University. He points out that common sense consists of simple rules that everyone knows—such as the fact that two objects cannot occupy the same space—but also of other rules that have yet to be recognized. If we don't know all the rules of common sense, he asks, how can we program an expert system to think as intelligently as a human does?

Expert system vendors challenged in court will probably claim that their products are the equivalent of textbooks. Howard Kramer, assistant director for market regulation at the Securities and Exchange Commission, says computerized investment advisers are no different than any other research report. But consultant Schwartz disagrees. "Our society puts more stock into what a computer says than what a textbook says," he says. "Computers give interactive knowledge."

Software makers may also claim that expert systems are still an inexact science. But that defense is also not expected to hold water. Predicting the weather may seem equally inexact, but three years ago the courts ordered the U.S. government to pay $1.25 million to the survivors of four fishermen who perished in an Atlantic storm. The men had relied on an inaccurate National Weather Service forecast.

Software companies that make expert-system shells—the software used to develop an expert system—or that develop expert systems only for their own internal use, may think they don't have to worry about liability suits. But many lawyers say their sense of security may be illusory. If a product fails because it was built on a flawed structure, that structure may be held liable. Expert systems built by a company only

FEDERAL RULES ON EXPERT SYSTEMS

While attorneys wait for lawsuits to clarify the legal risks of expert systems, the federal government is already enacting regulations to control the use of such programs.

In some cases, government agencies have applied the same measures they use to regulate human experts. In 1986, for example, the Internal Revenue Service began treating income-tax software the same way it deals with human tax preparers: If the program gives "substantive instructions" for completing a tax return and makes mistakes, it's liable.

Another agency, the Securities and Exchange Commission, short-circuited the development of an expert system proposed by Computer Language Research of Carrollton, Tex. The SEC refused to rule that the company's expert system would *not* have to register as a financial adviser—at least until the program was completed. Computer Language Research had wanted to create a version of its Financial Sense expert system that could make specific financial recommendations, not just generic ones, recalls product manager Steve Brown. The SEC, which draws the line at commercial computer programs that recommend specific stocks, left "the impression we might have some [legal] exposure there," Brown says.

The Food and Drug Administration has so far been the most aggressive expert-systems regulator because of its role in approving medical products. The FDA says the number of computerized medical products is increasing at an astronomical rate—so fast that this year the agency decided to specify what kind of software was *not* subject to review, a list that includes spreadsheets used in medical offices. Software that makes treatment decisions, however, still must receive FDA approval, and with good reason. In 1986, a software bug in a computerized radiation-therapy machine was blamed for the deaths of at least two patients undergoing treatment at a Texas hospital. The radiation machine in question was recalled by the FDA, and a lawsuit is now pending.

Ironically, the IRS, FBI, and Environmental Protection Agency are all developing or using expert systems on an in-house basis. Also, some law firms are using expert systems to judge when conditions are ripe to file a suit.

for its own use are less vulnerable, provided they affect the company's operations alone. But corporations could be held accountable to their customers or employees. The federal government, for example, is required to maintain an accurate database of information on its employees; the Privacy Act of 1974 lets federal workers who lose out on a promotion or raise because of errors in the data sue for damages.

Apart from the liability issue, expert systems also raise the question of who owns the knowledge in them. Dennis Deutsch, a computer lawyer in Hackensack, N.J., represents a client who provided the expertise for an expert system as part of his job. The client has since lost that job, but wants to receive royalties on the system he created. "My client is claiming the system is owned by him in the absence of a contract" to the contrary, says Deutsch.

To avoid ownership challenges, Deutsch says, "the employer must have an adequate pre-employment contract" with the expert whose knowledge is written into the program. Other steps that could help reduce the risk of litigation include

- accurately representing the system's abilities,
- creating a program that merely recommends particular actions, instead of acting on its own,
- avoiding software bugs,
- making sure disclaimers are legible, understandable, and likely to be signed, and
- obtaining liability insurance.

Despite the multitude of legal issues, few observers expect expert systems to wind up in the same dog house as nuclear power. Indeed, several expert systems are already in use.

For example, the Help system at Latter Day Saints Hospital in Salt Lake City assists doctors throughout the hospital in interpreting patient data, such as lab tests. According to Dr. Homer Warner, who led the system's development, the Help software is involved in approximately 80,000 decisions a day, and has improved the medical care of half a million patients in the 20 years since it came into use.

To reduce the risk of liability, the system was thoroughly tested and makes only recommendations, says Warner. In fact, Warner believes medical "expert systems are going to be the answer to litigation," by keeping doctors from making the errors that lead to suits.

Clearly, there are times an information-bearing product is so important that its utility must be recognized, litigation or not. This was the case with Jeppesen Sanderson Inc., a Denver company that converts government data into aircraft flight charts. After Jeppesen lost a major lawsuit in which its products had been blamed for an aircraft crash, the U.S. Congress took the unusual action of promising to indemnify Jeppesen if the government's data ever proved to be at fault. The action indicated the charts' value to the nation's air-traffic system, says company president Horst Bergmann.

Lawyer Marx believes a good next step would be for the courts to endorse the benefits of expert systems by subjecting them to a more forgiving liability standard. "We want to encourage people to innovate," he says.

The trade-off between benefits and risk will probably depend on how badly an expert system is needed. In poverty-stricken parts of the Third World, points out Ellen Staelen, a senior consultant at International Data Corp., a medical expert system could provide emergency advice, even for non-doctors. "When there's such a deplorable lack of resources," in these regions, she says, "one would hate to see the lawyers hold sway."

The public, not the experts, will ultimately decide the value and risk of expert systems, through lawsuits and regulations. Such decisions may involve a willingness to accept some level of danger. As a comparison, researcher Chandrasekaran wonders what would have happened to the automobile if, at its introduction, someone had warned, "Here's a technology that's going to kill 50,000 people a year." ■

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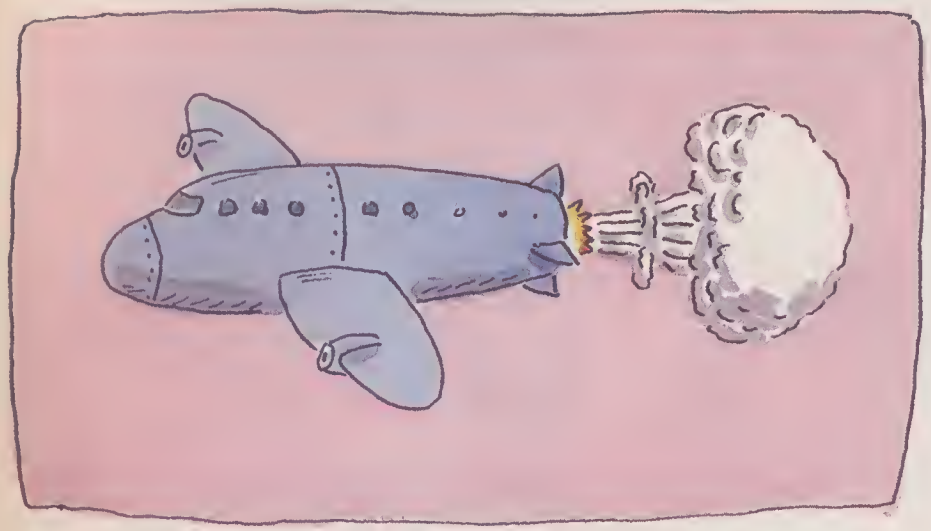
It Seemed Like a Good Idea At the Time

Technologies come and go. People celebrate new ideas, but pay little attention to those that fail. Here's a second look at some technologies that were supposed to make it big, but didn't.

BY HERB BRODY



NUCLEAR-POWERED PLANES

The General Dynamics proposal to build a nuclear-powered bomber epitomized the 1950s, an era when nuclear energy seemed the tool for almost any massive job, from blowing up a city to generating electricity to propelling a submarine.

Using conventional power to take off, the jets would cruise indefinitely on the energy produced by a small amount of uranium undergoing nuclear fission.

General Dynamic's research, started in 1951, culminated in the NB-36 bomber, which flew frequently between 1955 and 1957. Though conventionally powered, the NB-36 carried a 17-ton nuclear reactor built by General Electric.

A nuclear jet was operated in 1956, but only in a wind tunnel. Air sucked into the turbine was heated by fissioning uranium. Hot exhaust expelled from the back provided thrust. Problems arose, however, in efficiently transferring large amounts of nuclear generated heat to the air.

That's as far as it went. President Kennedy killed the program in 1961. A major concern was that such a plane might crash and contaminate large areas with radioactivity. Fortifying the reactor against such an impact would have made it unacceptably heavy. ■

JETPACKS

If they gave out awards for pure technological dazzle, then an honorable mention should go to the personal jet engine—one of the gee-whizziest gadgets ever invented. A highlight of the 1964-65 New York World's Fair was a stunt pilot donning a rocket backpack and zooming over the Unisphere.

The U.S. Army started funding research on jetpacks in the 1950s; Bell Aerospace developed the rocket pack of World's Fair fame. To save weight, the rocket pack carried only enough liquid-hydrogen fuel to fly for 21 seconds. The Army elected not to buy any.

In the late 1960s, Bell and Williams International, a specialist in small jet engines, offered a "jet flying belt" that could fly for about 10 minutes. Better, said the Army—but no thanks.

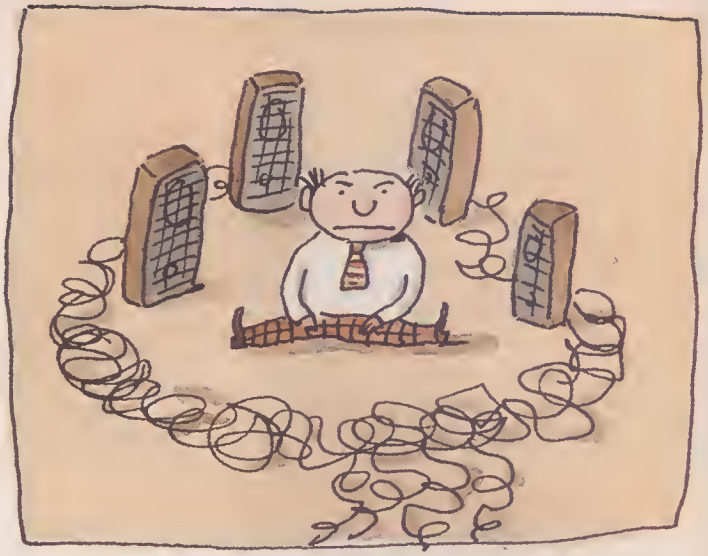
Losing interest in the program, Bell licensed its technology to Williams, which created the Williams Aerial Systems Platform, or WASP. Developed for the Marine Corps, the WASP mounted on a small structure with handlebars—a sort of jet-powered motorcycle that flew. The pilot could hover or move in any direction by leaning and turning the handlebars.

But WASP had no compelling military justification; a flying soldier would be ridiculously easy to pick off. The Marines dropped the idea and the Army picked it up again. In the early 1980s the WASP II was built; it stayed aloft for half an hour and reached 60 to 70 miles per hour. The Army only test-flew a prototype.

And there the story ends—almost. No money is now being spent on personal jet flight, but an engine very similar to the tiny one that powered the original prototype has been chosen by the Navy for its F-107 cruise missile. ■

ILLUSTRATIONS BY MARC ROSENTHAL

QUADRAPHONIC SOUND



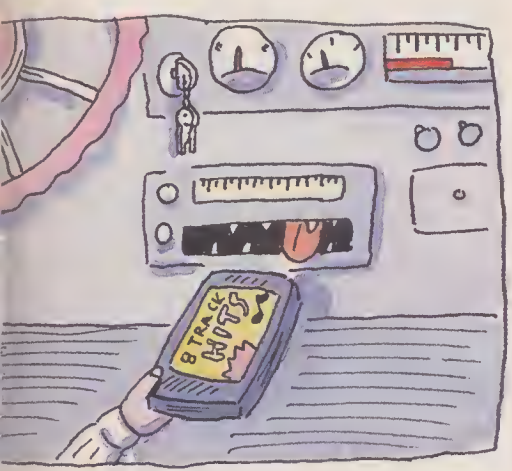
If stereo sound is good, then "quadraphonic" sound—music split four ways instead of two—would be better, right? Unfortunately, quad sound was a market fiasco.

There are plenty of reasons for the flop. For one thing, it's practically impossible to hook up four speakers in a typical room without running wire across a doorway. Moreover, quad speakers provide only "a relatively minor improvement" in sound quality, says David Lachenbruch, editorial director of *TV Digest*, a newsletter covering the consumer-electronics industry.

Also, the audio industry never established standards. Arch-rivals RCA and CBS championed incompatible formats. Records made with the CBS SQ system would not deliver quad sound unless played on SQ equipment; RCA's system, CD4, required a special stylus.

The technology might have had a better chance if it had caught on with FM broadcasters. But the proliferation of CB radios in 1973-74 created nagging radio-wave interference, which forced the FCC to cancel plans for a quad-broadcast standard—despite an $8-million, three-year lobbying effort by audio companies. ■

EIGHT-TRACK TAPES



In retrospect, it seems obvious that eight-track tapes would fizzle. The fact that these klutzy systems enjoyed any success at all demonstrates the crudeness of mid-1960s audio technology.

In the early 1960s, consumers could get high-fidelity sound from records, FM radio, or reel-to-reel tape. Records and open-reel tape were obviously inappropriate for cars, and it was difficult for car radios to receive FM stations.

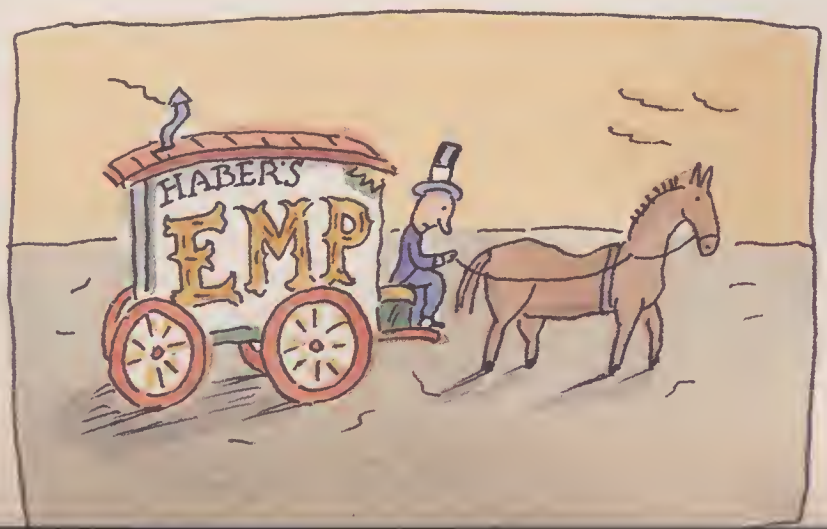
First came the four-track, developed by Learjet for its private aircraft. Next, Lear joined with RCA and Motorola to produce eight-track devices.

Ford ordered eight-tracks for some of its 1965 models. "We went from scratch to full production in nine months," recalls Oscar Kusisto, then general manager of Motorola's automotive sector. Millions of eight-track decks were sold, but the curtain rang down almost as quickly. Mechanically, eight-track tapes were too complex. The arrival of audio cassettes in the late 1960s, coupled with improvements in FM broadcasting, marked the end of the road for eight-track tapes. ■

ELECTROMOLECULAR PROPULSION

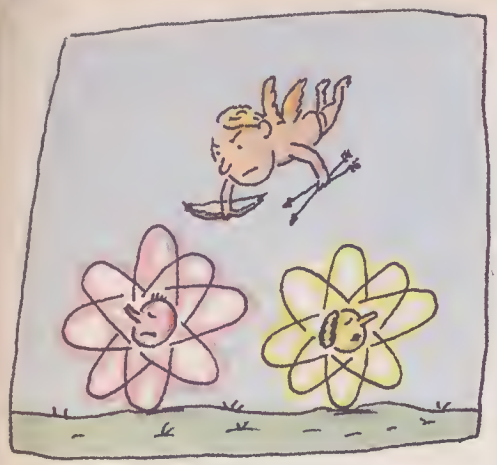
Consider the case of Norman Haber. In 1982, this inventor from Towaco, N.J., proclaimed a new method of chemical analysis, dubbed electromolecular propulsion (EMP). This method promised to handle in minutes analyses that took hours or longer using conventional techniques.

According to Haber, EMP involves electrically neutral molecules, such as dyes, that move across a filter paper when a high voltage is applied. Molecules of different weights move at different speeds in the electric field, sorting themselves for identification.



Haber said that the high-voltage process made possible a simple, one-minute procedure for testing blood for high-density lipoproteins, which are linked to heart disease. Publicly owned Haber Inc. established a subsidiary, Life Signs, which planned to operate a nationwide network of centers that would use EMP to test blood.

Today, Life Signs runs only one center, which uses conventional analysis tools, not EMP. Undaunted, Haber says his company will market an EMP machine this year. ■



FUSION ENERGY

Proponents of fusion energy have long hoped to harness the process that makes stars shine. But despite billions of federal research dollars, fusion has yet to produce a single microwatt of electricity.

All the brilliant scientists working on fusion—the joining of light atoms to make heavy ones—have yet to solve the most basic problem: how to confine the fuel when it becomes superheated to the point where atomic nuclei overcome their natural repulsion for each other.

The best U.S. hope for fusion is Princeton's toroidal fusion test reactor (TFTR), which uses huge magnets to confine hot hydrogen nuclei in a doughnut-shaped chamber. Scientists hope the TFTR will put out as much energy as it takes to run the magnets and heat the fuel. A practical reactor will need "ignition," a self-sustaining fusion flame requiring no energy input.

But the TFTR reactor has only made dry runs, using only the hydrogen isotope deuterium. A practical fusion reactor also requires tritium, a radioactive isotope. Scientists are trying to solve as many problems as possible using straight deuterium before adding "hot" tritium. To reach the ignition stage, scientists must heat the fuel 10 times hotter than current temperatures. ■

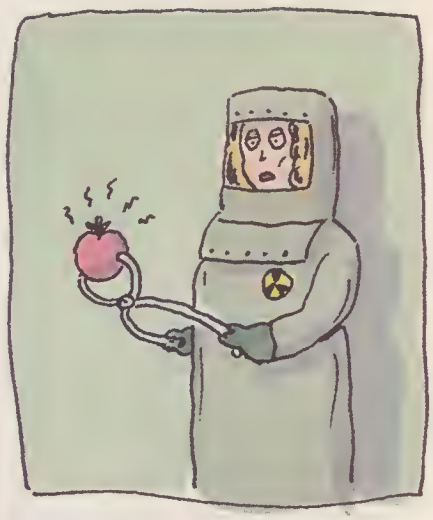
FOOD IRRADIATION

Talk about an image problem. Here's a process that rids food of fungi, insects, and bacteria. It keeps produce from spoiling and sprouting. It removes the risk of trichinosis from uncooked pork and salmonella from chicken and, unlike chemical treatment, leaves no residue in the food. Some two billion tons of food are treated with radiation annually in 19 countries; the Soviet Union alone irradiates about 800 million pounds of grain a year. Yet despite vigorous promotion by irradiation companies, the process is virtually unused in the United States.

The food industry sees little incentive to adopt the technology. Companies worry that implementing irradiation would suggest that unirradiated food is unfit. Zapping chicken, for example, would rid the meat of salmonella and lysteria—but starting the practice would call attention to the presence of those germs in untreated chicken.

The government classifies irradiation as an additive, so irradiated food must be labeled as such. Food packagers and meat and produce distributors fear public resistance to anything bearing the word "radiation." Sometime this year, the Food and Drug Administration may reduce its requirement, permitting a label to carry only a standard logo symbolizing irradiation.

The food industry's indifference to irradiation has forced the two companies supplying the service, Radiation Technology Inc. and Isomedix, to focus on the medical market instead.



Isomedix president John Masefield sums up the situation: "We're ready to irradiate food, but the initiative must come from the food companies." ■

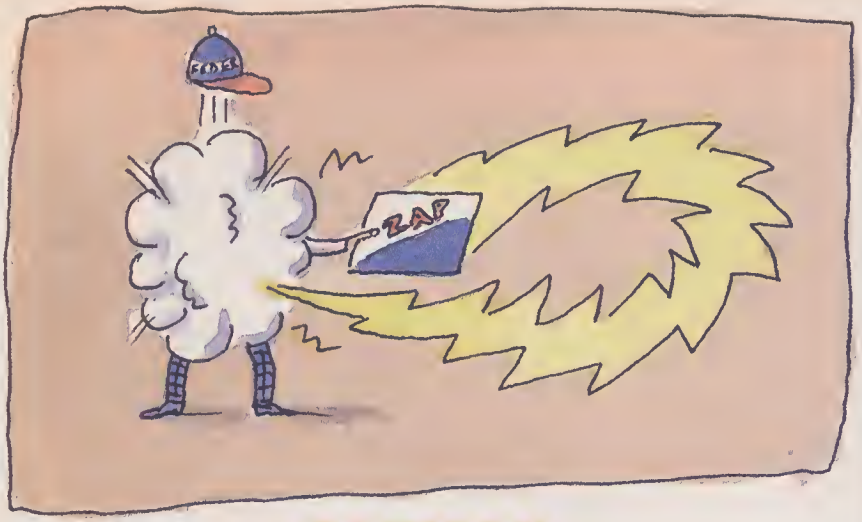
ROTARY ENGINES

Back in the 1960s, designers came up with a car motor that uses a spinning rotar instead of pistons. The rotary engine, sometimes called a Wankel engine, has fewer moving parts than the piston type and runs more quietly and smoothly. Rotary engines also pack a lot of power into a small space—twice the horsepower of a piston engine with the same displacement.

The rotary engine spearheaded Mazda Motor Corp.'s entry into the U.S. car market in 1970 with rotary-equipped sedans and a truck. Detroit perked up its ears; General Motors spent $50 million readying a rotary-engine car.

But rotaries had problems. The seals that closed in the moving rotors wore out quickly, and the rotary attained its high power only at high engine speeds, performing comparably poorly at low speeds. The engine also tended to pollute and guzzle gas. By 1976, Mazda had switched entirely to conventional piston engines. GM and Ford have halted or severely curtailed their rotary-engine development.

In 1978, Mazda introduced the RX-7 two-seat sports car with a rotary engine. Mazda claims to have licked the sealing problem, and says a catalytic converter cleans the exhaust. More than half a million RX-7s have been sold in the United States. ■



ZAPMAIL

Federal Express, which practically invented the prosperous business of overnight package delivery, in 1984 introduced another pacesetter: Zapmail. If overnight was good, then two-hour delivery would be even better. But Federal stubbed its toe.

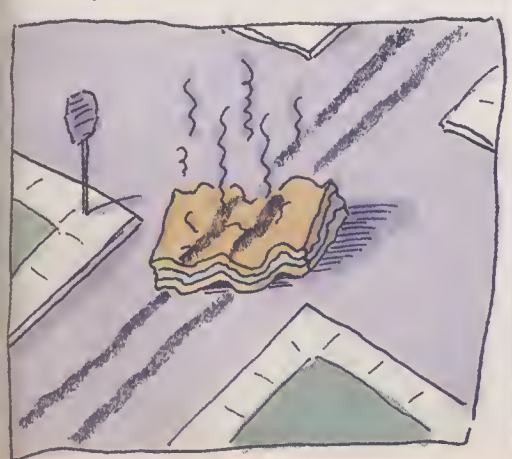
Zapmail relied on facsimile technology. Customers either leased a Zapmail transmitter-receiver, or they handed their documents to a courier, who took them to the local Federal Express office for zapping. Laser printers produced crisp reproductions on bond paper, which was much more distinctive than the thin, coated paper most of today's fax machines use.

Federal, however, couldn't manage its telecommunications network, a patchwork of satellite links and terrestrial lines supplied by telephone companies. Concedes spokeswoman Shirlee Finley: "We had a lot of problems with the hybrid network."

In response, Federal decided to orbit its own satellite. The company reserved a berth on the space shuttle for 1989, but Challenger's crash in January 1986 pushed the launch to 1992 or 1993. That was too long to wait and Federal axed Zapmail in September 1986, swallowing a pre-tax loss of $340 million. ■

JOSEPHSON JUNCTIONS

A graveyard of electronics technology would devote a big, expensive tombstone to Josephson junction processes. IBM alone spent $300 million trying to groom these ultrafast, low-power devices for use in general-purpose computers. The company quit its 15-year effort in 1983, concluding Josephson junctions did not justify their additional cost and complexity.



A Josephson junction consists of two superconducting films separated by an insulating layer that prevents current from flowing between the films when the junction is turned off and lets it flow when switched on. The switch between on and off is five times faster than that of the best silicon transistors.

Throughout the 1970s, researchers at IBM, AT&T Bell Labs, and Fujitsu intensively developed superconducting switches. At its peak, IBM had 100 people working on the technology. But conventional silicon chips kept getting faster, and the incentive for developing Josephson junctions dwindled.

IBM never achieved its grand vision of a superconducting computer, but Josephson technology has recently come to market in a more narrowly targeted product. Hypres of Elmsford, N.Y., is producing Josephson chips for a super-high-speed oscilloscope, which monitors electronic circuits. ■

BUBBLE MEMORIES

Bubble-memory chips offer the best features of two other data-storage technologies. Like silicon chips, they are rugged, solid-state devices with no moving parts; like magnetic disks, they retain data after the power is turned off and are relatively unaffected by radiation. However, rapid improvements in silicon chips and floppy disks made bubble memories obsolete before they ever established a market foothold.

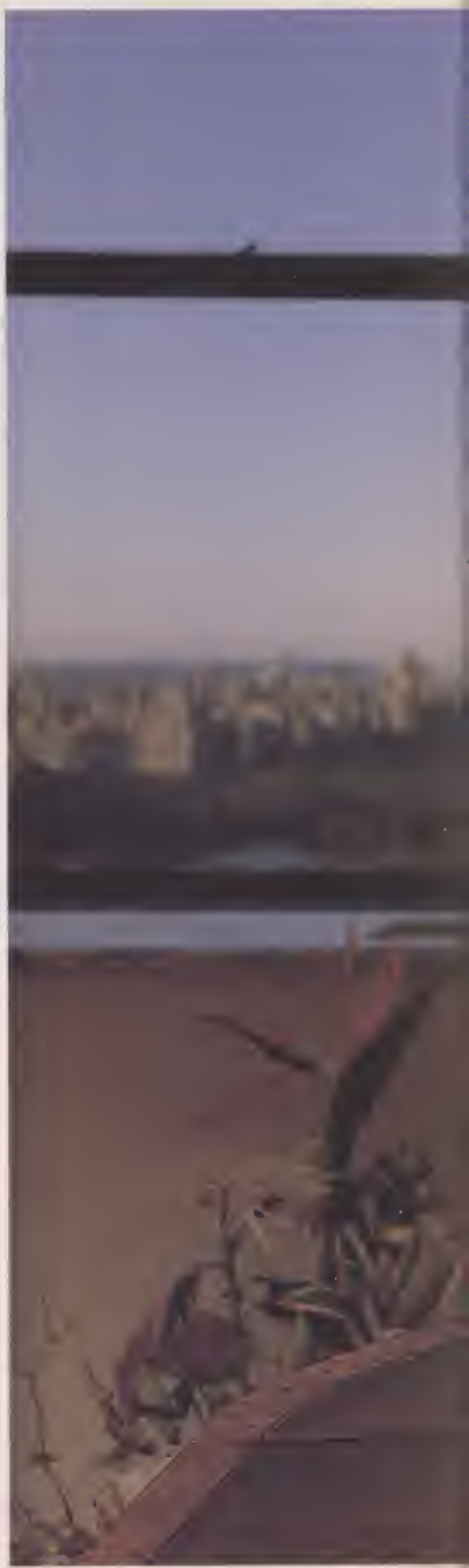
Beginning in the late 1960s, organizations such as Rockwell International, Bell Laboratories, and Texas Instruments poured tons of money into bubble-memory development. "It looked like a good way to replace disks," says Texas Instruments fellow Clifton Penn, who ran the company's bubble-memory program.

A bubble-memory device consists of a thin coating of garnet on a nonmagnetic base. Binary ones and zeros are represented by minute regions in the film that are magnetized oppositely from the rest of the film. Data can be retrieved from such devices about 10 times faster than from a rotating disk.

Texas Instruments ran farthest with the idea. The company built a pilot production line for 160-kilobit memories and marketed a bubble-memory computer terminal. Much of the impetus came from then-CEO Pat Hagerty, a Bell Labs alumnus. Hagerty's retirement let the air out of TI's bubbles; by 1978, the project was history. ■

NTT Chairman Dr. Hisashi Shinto

ON MANUFACTURING IN THE INFORMATION AGE



Dr. Hisashi Shinto

Born: July 2, 1910
Joined NTT: 1981
Revenue controlled: $43.2 billion for fiscal 1988
Employees: 297,000
1988 R&D budget: $1.68 billion

IN TERMS OF MARKET capitalization, Nippon Telegraph & Telephone (NTT) is the largest corporation in the world. Its 15.6 million outstanding stock shares sell for about $20,000 each, making the company worth about $312 billion.

In 1985, the Japanese government ended its ownership of NTT and also phased out the company's 33-year monopoly of Japan's telecommunications market. The man leading this transition is Dr. Hisashi Shinto, a retired shipbuilder nicknamed "Dr. Streamliner" because of his enthusiasm for automation. Hired as president and CEO in 1981, the 78-year-old Shinto recently gave up operational control to become chairman.

NTT does not manufacture equipment, but maintains extensive research and development arrangements with outside companies. In the past, almost all these manufacturers were Japanese, but NTT is under growing pressure to work with foreign suppliers, including U.S. companies.

Associate managing editor Fredric Paul spoke with Shinto through an interpreter about the relationship between information technology and industrial strength.

■*HT Business: Unlike the Bell companies in the United States, which are fighting for the right to build equipment, NTT doesn't want to manufacture. Why not?*

SHINTO: When we were being privatized, there were many discussions as to whether NTT should manufacture

BROWNE HARRIS

or not. But I made a very clear declaration that we were not going to. I thought that trying to produce products for our own use would be almost like duplicating the old inefficient monopoly system we were trying to move away from. On the other hand, I made it very clear that we would strengthen and reinforce our research and development capabilities.

Of course, many Japanese manufacturers also expressed their opposition to NTT developing a manufacturing capability. Telephone-equipment makers in Japan grew strong selling their products to the old NTT. The NTT connection helped Japanese companies develop to the point where they could be independent of us. They became export-driven and export-dependent. In light of that, we didn't think it would be reasonable for NTT to take a role in manufacturing.

■ *HT Business: How do the U.S. companies that you work with compare to Japanese suppliers?*

SHINTO: In the past, Japanese manufacturers worked very closely with NTT in a closed market. They got used to providing products that would satisfy all our requirements, so it was much easier for NTT to place orders with Japanese outfits than to develop new relationships with foreign suppliers.

It's been almost seven years since we first had contact with U.S. suppliers, and they have come to realize the high standards our Japanese manufacturers had been providing. In terms of the quality of their products, we no longer see any difference between Japanese and U.S. companies.

■ *HT Business: Has the falling dollar and the rising yen had any effect on your purchasing plans?*

SHINTO: Before the recent fall in the value of the dollar, it was more expensive to buy from U.S. producers than from Japanese producers. But it has become easier for us to buy from U.S. companies. Of course, even if the exchange rate had remained as high as 210 to 220 yen to the dollar, the United States could still compete with Japan.

■ *HT Business: There's been talk that U.S. companies are using the fall of the dollar to boost short-term profits instead of trying to gain market share by cutting prices.*

SHINTO: I think, in the past, U.S. companies were not making enough efforts to reduce their production costs and implement thorough quality control. They didn't take a steady interest in that area; they were too much like merchants, running after the very short-term profit. That was a major flaw.

I think this has changed. With regard to those U.S. suppliers with which NTT is now doing business, I see a great change—they have become almost like their Japanese counterparts. We have business relationships only with U.S. companies that think that way.

■ *HT Business: Do you see a commitment in the United States to the kind of manufacturing that is still the linchpin of Japan's success?*

SHINTO: I have the impression that, recently, there has been a positive change in the basic attitude concerning manufacturing in America.

The manufacturing industry supports the basic development of human society. The extent to which that industry can be operated in an efficient manner determines what sort of advanced economic society we will have. So you really have to look at service-oriented industries in that respect.

The basis of the economy in most areas will be manufacturing. To support countries with 100 million people or more, a strong manufacturing industry as a foundation of economic power is necessary for economic survival. Of course, manufacturing must be supported with a certain amount of agriculture, fishing, and forestry to keep a balance. But the most important base has to be manufacturing.

■ *HT Business: That's an interesting perspective for the chief executive of a communications-service company. What role does communications and information play in the kind of economy you've described?*

SHINTO: The essential and indispensable industries are the primary industries—agriculture, fisheries, forestry, and mining—as well as the secondary industries, which involve manufacturing. The economy depends on the primary and secondary industries growing in a very stable and healthy manner.

The role of telecommunications and information services is to raise the productivity of the country's primary and secondary industries. So, although the telecommunications and information industries play a great role, they cannot stand on their own. Their reason for being is to support the primary and secondary industries.

"The role of telecommunications is to raise the productivity of the country's primary industries."

■ *HT Business: So even in the "information age," you see information as a support for manufacturing and primary industries.*

SHINTO: Yes. The value of the information industry lies only in its ability to improve productivity in the primary and secondary industries. The information industry in itself has no capability of producing anything.

■ *HT Business: Do you think people in charge of the U.S. economy understand this?*

SHINTO: I think there has been a major change. That's why the dollar dropped. I think the healthy common sense of the American public has not stopped functioning. I think that is quite evident if you look at what is happening in U.S. manufacturing, and I can really see it from my own experience working with U.S. companies.

When I first became president of NTT, U.S. manufacturers trying to sell their products to us would say, "We have this

sort of product; you should buy this." They don't say that anymore. Now they say they'd like to study our requirements and specifications, and conduct joint development and research activities to create the optimum products for us. They want to build a long-term relationship.

So I think top executives at U.S. companies have been changing their attitudes—moving in a much better direction. As a result of an increased drive for exports and the depreciation of the dollar, I think the United States is starting to show its potential power. I'm really happy to see that this healthy state is now being recovered.

■ *HT Business: Many Americans don't believe that recovery is real, and are looking for legislative help. Do you see trade protectionism as a problem?*

SHINTO: I am optimistic, because I get the impression that the leaders in the United States, Japan, and Europe have started to realize that protectionism amounts to suicide if you look at the future of the global society.

■ *HT Business: But a lot of Americans seem to feel that protectionism already exists. Do you think that Japan, and NTT in particular, constitutes an open market?*

SHINTO: Calling the Japanese market closed is a very one-sided view. In the past, I don't think U.S. companies were very interested in exporting into the Japanese market; nobody can really deny that fact. On the other hand, many U.S. manufacturers with far-reaching plans have come to Japan and established their companies—or worked with Japanese firms in joint ventures—and have achieved great growth in the Japanese market.

Remember, when the U.S./Japan trade friction began, many of the Japanese products exported to the U.S. were produced by U.S. companies operating in Japan. Now, the Japanese companies are coming to the United States for design and production. I think this sort of activity is contributing greatly to the solution of the big problems we've had.

■ *HT Business: Let's talk about NTT. What was the original reasoning behind the Japanese government making the company a private organization?*

SHINTO: It wasn't just NTT that was privatized; there was also Japan National Railways and a tobacco monopoly. When these operations began, the Japanese economy was less mature and the country lacked sufficient strength in technology for these businesses to stand on their own. But with the passage of time, government-run monopolies tend to become very inefficient. That was the case in Japan, especially after World War II. Japanese private industry created an atmosphere in which they tried to prove their technology and increase productivity, yet the monopolies stayed just the same, without raising productivity or rationalizing personnel costs.

These government-owned monopolies would just raise their rates as they pleased. This was very unreasonable, and the general public in Japan started feeling that they couldn't stand this anymore. So the government began to recommend specific measures to address the monopolies' inefficient operations. That was the start of the process.

■ *HT Business: The Japanese government has also introduced competition into the telecommunications industry. Do you see parallels between NTT's experience and that of the U.S. telecommunications industry?*

SHINTO: Not exactly. I think the philosophies that underlie these changes in the two countries are quite different. AT&T was a private company, and the deregulation and divestiture of AT&T was born out of antitrust law in an attempt to eliminate a concentration of power in one specific area.

This was not the case in Japan. Therefore, if you look at the legal framework of telecommunications in the United States after the divestiture of AT&T and the legal structure of telecommunications in Japan after the privatization of NTT, you see a very clear difference.

■ *HT Business: What was NTT's biggest challenge during the privatization process?*

SHINTO: Trying to change the mentality of the people working within the company. We had to undertake a full-fledged overhaul to try to change their mindset from that of a government-run monopoly to that of a private company able to survive fierce competition.

■ *HT Business: How has privatization changed the way the company operates?*

SHINTO: Everything has changed. When we were a government-run monopoly, all the operating costs had to be within the set budget provided by the government. The budget system and the way it was managed were all in line with what other government administrative ministries were doing.

Of course, this sort of management won't do for a private company, so we had to make a complete and very basic change in all of it.

■ *HT Business: Has that change been positive?*

SHINTO: I think we're still far away from the most desirable management for a private company, but I feel that we have probably come about halfway.

■ *HT Business: Now that NTT has become a private company, what do you see as the next step?*

SHINTO: NTT will remain the telecommunications services and facilities supplier in Japan, operating in a very competitive situation. We will try to reduce and rationalize costs.

More than anything, we feel that we need to bring down telephone rates in Japan, especially long-distance rates. Long-distance fees are really high in Japan compared with the United States or any other country. We have already cut rates in half compared to six or seven years ago, but competition with the new carriers in Japan will force rates down to the international standard.

■ *HT Business: Why is it so important to reduce long-distance rates?*

SHINTO: Well, if you have to pay so much money to make a call, it can't be the information age yet.

■ *HT Business: As you move from president to chairman, how will your role at NTT change?*

SHINTO: I'm hoping to get out into telephone offices all over Japan as much as possible. I want to teach the workers how they can give up their monopoly habits and improve the way they do their work. I want to cause lots of competition within the company so we can substantially reduce our total costs. Our situation is just like the time when the Pilgrim fathers came from Europe to America and tried to develop the country. There is a lot to do. ■

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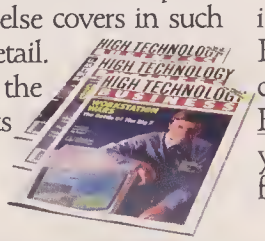

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Insuring

BY JENNIFER CHRISTENSEN

THE THUNDER cracked, but the sound of the falling tree crushing the car was even louder. At least it was insured. But as many people have learned the hard way, sometimes the insurance-claim process can be even more painful than the damage itself.

Wouldn't it be nice if the insurance company could settle the claim after just one phone call, arranging the appointment with the insurance inspector at the same time? United Service Automobile Association (USAA), the sixth largest insurer of personal automobiles and the seventh largest homeowner insurer in the country, claims its claims-processing automation system defies the mandatory bureaucracy of the insurance business and allows it to offer that kind of service.

ANNE GOFFIN-SMITH

An ACE in the hole makes the USAA insurance company a winner

USAA was founded in 1922, little different from any other insurance company at that time, except that it catered to military officers. This market niche proved to be a cornerstone of stability for the company; USAA has grown into a $12-billion heavyweight that is the envy of the industry. Today, USAA insures 1.8 million people, including 90 percent of all U.S. military officers.

The visionary behind the rise of USAA is retired Brigadier General Robert McDermott, known as "McDee" to his USAA comrades. McDermott began his term as president of USAA in 1969, when employee turnover stood at 43 percent. Now, after 19 years of McDermott's influence, turnover is down to just 9 percent. This low turnover rate is even more significant in light of the company's tremendous growth—from about 3,000 employees in 1969 to more than 10,000 worldwide today.

Clearly morale has improved, and observers credit much of the improvement to McDermott's drive to create a corporate climate of satisfying the worker in order to satisfy the client.

Just as important, however, is the development and installation of USAA's Automated Insurance Environment, or AIE. More than just a computer system, the AIE is a set of standards, utilities, and procedures that define the hardware architecture used by the company's insurance representatives as they process and file claims.

The Automated Insurance Environment is designed to deliver any automated function through one terminal. "We want our employees to be able to access any business function they need from a single terminal, using similar procedures, regardless of the line of business that they are working with," explains Mike Howard, vice president

of systems planning and administration at the company's Property and Casualty division.

USAA spent $14 million and three years to develop the system, and the first installations began using the new concept in 1985. In return for that investment, AIE standardization reduces costs associated with economies of scale, such as firing up the company's new banking services division. USAA can therefore spend more on research and development and on improving the quality of its insurance products. The AIE boosts productivity and efficiency, cuts paper flow drastically, and virtually eliminates time and money spent training employees to process new types of insurance policies. "Why reinvent utility functions that exist independently?" reasons Howard.

The most obvious success fostered by the AIE program is a system developed by the Property and Claims division. In use since 1979, this top gun of insurance automation is dubbed ACE, for Automated Claims Environment. The system has transformed the way USAA does business, and has contributed to an annual growth rate of 6 percent in the division.

ACE is an expert-system—a software program that emulates the knowledge of experts, using the rules they follow in doing their jobs. The system allows uniformity and thoroughness when gathering claims information.

The advent of the ACE and AIE automation systems means that fewer people can handle more policy holders. For example, in 1952, one person managed 290 policies, but by 1985 that number had expanded to 1,003 policies per person. Michael Takata, an analyst with Drexel Burnham Lambert, says that part of USAA's efficiency comes from its decision to transact all of its business over the telephone and through the mail. Removing expensive personal contact with clients reduces the time spent on each claim.

Despite the lack of personal interaction with customers, USAA gets an A+ on service from Paul Wish, vice president of A.M. Best, a corporation that rates U.S. insurance companies on their financial stability. "I have heard people say nothing but good things about USAA's services," says Wish.

Before USAA installed the ACE system, the claims process was a veritable maze of paper and procedures. Claims were taken over the phone and later entered into a computer. When a client called for service or information, USAA service representatives had to go to a terminal away from their desks to find the policy information. At that time, USAA had only 25 terminals for its 400 employees in the San Antonio Property and Casualty office. This situation often resulted in a long wait just to access information, especially on Mondays and in emergency situations. Customers usually had to be put on hold, called back, or both. Frustration levels ran high for both clients and employees.

Processing a claim before ACE took 18 people performing 55 steps over 12 days. One quarter of each day was spent looking for files. With ACE, a claim takes one person one step, and the process is finished in just two days.

■

USAA's automation systems have helped change the company from a niche player into an industry force.

■

That kind of automation lets USAA concentrate on selling new policies and on creating new varieties of insurance instruments, because the claims procedures for all types of policies are so similar. And no matter what the question, client information can be accessed instantly simply by cross-referencing existing files.

The ACE system displays all of a client's coverage data on the terminal screen, and also prompts the service agent to ask the appropriate questions for gathering complete claims information. After the questions are answered, the system provides the agent with a list of repair locations that are most convenient for the client, as well as a list of available appraisers and their schedules. The USAA representative can schedule an appraisal appointment directly through the ACE system, and the automated environment even makes sure that the proper checks are issued and the appropriate letters sent. If more work, investigation, or approval is required, the case is tagged and sent to a supervisor's terminal for further attention.

In addition, the ACE system offers a "diary" function that works as an online time and schedule manager. When employees log on to their terminals, the diary alerts them to calls they have to make that day and lists other tasks and events on their schedule. The diary keeps track of all client files consulted and smooths transitions when more than one USAA representative has to work on a particular case. Meanwhile, a "scratch pad" capability lets ACE users make notes about calls to clients, and also record information about a client's special needs or circumstances.

Behind ACE's easy agent interface is special software developed by USAA vice president Bob Wheeless that runs on IBM's 3090 mainframes and Digital Equipment's VAX clusters. The system is tied to the company's financial system, so paid-out checks and other expenses are automatically registered in the company's account records.

Because ACE was created specifically by and for USAA, it fits the company's needs more precisely than can generic automated claims systems developed by third parties such as IBM, RiskMap, and McCracken Computers. Other insurance companies that have gone to the trouble to create their own systems include Progressive Corp. of Cleveland, Ohio, and Geico of Washington, D.C. Like USAA, Geico also communicates entirely through the telephone and the mails.

USAA has been remarkably successful with automation. Its automation systems have helped change the company from a niche player into an industry force. The USAA Group has grown to include 36 wholly owned subsidiaries and affiliates providing insurance and financial services such as property and casualty insurance, life and health insurance, a discount brokerage service, and a travel agency.

The company is not resting on its laurels; an enhanced version, ACE Plus, is due to be phased-in between 1990 and 1992 for use by 3,500 claims specialists. George Allen, a trainer and developer for the new system, will update the loss-reporting process, add more in-depth features to the expert system, and help service representatives identify clients who pose fraud risks to the company. ■

which such a function was confirmed in a superconducting device.

The new fabrication process involves three steps. In the first, a sputtering technology is employed to smooth and polish a high-temperature superconducting thin film's surface to a mirror-like gloss. In the second, the film surface is stabilized with a coating of silver. The last step involves cryogenic temperatures. Using high-temperature materials on both sides of the device would allow use of liquid nitrogen, a less expensive coolant.

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TEC REPORT

Superconducting Chips Get Automated Design

Hitachi Ltd. has developed what it says is the world's first computer-aided design system for the automation of the wiring arrangements of superconducting devices.

Such devices are expected to replace conventional computer chips in the 1990s. Compared with the popularly used MOS devices, superconducting chips, a catagory which includes Josephson junction devices, feature design rules that are completely different in terms of positioning and wiring transistors.

Hitachi's design program uses new technology for determining the connection order of the transistors, and selects wiring based on current flow direction. In a trial run, the system automatically designed a 100-gate Josephson junction circuit.

The wiring and chip area were roughly equivalent to that accomplished through human design, but took one-tenth the time and one-tenth the manpower used in conventional methods. Noting that the system became more effective in designing larger-scale ICs, Hitachi said that the time and manpower required for designing a VLSI chip for super-high-speed computers could be reduced to a hundredth of the present level.

Breakthrough Could Create Ultra-Fast Chips

Toshiba Corporation has developed a new thin-film formation technology for high-temperature superconductor material. This new technology opens the commercial possibility for developing superconducting computer chips.

Researchers at Toshiba have succeeded in combining lead and yttrium-based superconducting material to form a "tunnel junction." This type of junction is essential for the fabrication of Josephson-junction semiconductor devices.

A prototype device fabricated under Toshiba's method showed that its voltage could be used to provide on-off switching functions. This prototype operation reportedly represents the first instance in which such a function was confirmed in a superconducting device.

The new fabrication process involves three steps. In the first, a sputtering technology is employed to smooth and polish a high-temperature superconducting thin film's surface to a mirror-like gloss. In the second, the film surface is stabilized with a coating of silver. The last step involves forming a tunnel junction between two superconductor films after inserting an insulator film between them.

A yttrium and barium copper oxide superconducting film which was fabricated with this process showed zero electrical resistance at 80° K. Also, the silver-coated film placed over the yttrium-based material displayed superconductor characteristics at the same temperature.

In experiments, lead was the other part of the superconductor, and 4.2° K liquid helium cooled the materials to cryogenic temperatures. Using high-temperature materials on both sides of the device would allow use of liquid nitrogen, a less expensive coolant.

CONTENTS

SEMICONDUCTOR ECONOMICS REPORT

Wafer Processing Resolution Dropping

The optimum wafer-processing resolution for minimum part cost has been steadily decreasing during the 25-year history of integrated-circuit production. The present range of 1.5 to 1.0 microns of minimum production line widths and spacings is a result of economic requirements, not performance requirements. Basically, because processed silicon costs are directly related to the area, the smaller a gate or transistor can be successfully processed, the lower the cost.

There are two factors. The first is a geometric relation, where the cost is reduced as the square of the scaling factor. For example, when scaling down from a two- to a one-micron process, the scale factor is two, and the area which is equivalent to cost (in theory) is reduced by two squared, or a factor of four. Actually, the cost is reduced even more.

The second is a yield factor, typically 75 percent of the scaling factor. Because wafer probe yield is a function of the number of defects per area, the smaller the area requirement for a gate, the more chance of missing a defect. Thus, the total cost improvement is typically five to six times for a scaling factor of two. These benefits are compensated by the increasing equipment cost to obtain a higher resolution.

Advanced MILITARY COMPUTING

Chips to Aid Search for Life in Space

The National Aeronautics and Space Administration plans to fund the development of high-speed custom integrated chips to help search for extraterrestrial intelligence.

The new circuits will be used for signal detection in a low signal-to-noise environment—i.e., in the search for radio waves from alien cultures, NASA says. Other tools to be used in the search include a wideband radio frequency spectrometer with more than 100 million channels and high-speed/high-density data-storage media. The project will support a field center for the space-alien search at Ames Research Center in Moffet Field, Calif.

Expert systems will be used for autonomous archiving, signal test and verification, and telescope scheduling and control.

The search for alien intelligence is part of NASA's Small Business Innovation Research (SBIR) solicitation, which includes many computer-oriented research projects. NASA plans to select 200 projects for funding under its current SBIR program. Each project will get up to $50,000 in Phase I of the effort and about half the contractors will receive Phase II contracts of up to half a million dollars.

NASA will fund up to four projects in teleoperators and robotics under the SBIR program. Project titles include telerobotic system planning and design, telerobotic systems software development, and robotic adaptive grasping systems.

NASA has invited proposals on AI for space-station applications. Tasks could include:

- intelligent control of robotics for navigation, assembly, maintenance servicing, and retrieval, including intelligent robotic control software
- intelligent systems for process control, fault diagnosis, repair, data monitoring, and crew schedule planning;
- self-updated systems for space-station module subsystem management.

SUPERCONDUCTING

The Cambridge Report on SUPERCONDUCTIVITY

AT&T Develops Non-Copper Superconductor

From AT&T's Bell Laboratories comes the announcement of the first verified high-temperature superconductor (HTSC) that does not contain copper. Unlike the copper-based compounds (cuprates) that superconduct best only in a specific

direction, the new material carries current efficiently in all directions.

The new development will have two immediate effects on the SC field: Fast and furious development work to exploit the breakthrough and raise the new material's low SC temperature, and fast footwork among the theoreticians who don't yet fully understand the original copper-based compounds and now must attempt to develop a theory to explain the new material.

The new compound is barium potassium bismuth oxide, which has a perovskite crystal structure—as do the copper-based HTSCs. Its formula is $Ba_{0.6}K_{0.4}BiO_3$. Bismuth is the element that replaces the copper, which is the active metal in the rare-earth-based 1-2-3 compounds, the bismuth-substitute cuprates, and the thallium-substitute HTSCs. The new compounds can be referred to as "bismuthates."

The new advance is at the same time a retreat. Tc (the temperature at which zero electrical resistance is reached) is back to 30° K, which is about the same temperature that Bednorz and Müller found in their original development of the lanthanum cuprate superconductors.

Robert Cava of AT&T Bell Laboratories, one of the developers of the new compound, says that "the new discovery may represent ... a new family of materials with high Tc." Bell Laboratories and many other organizations are hard at work attempting to optimize the new materials and trying various other elements as substitutes for (or additives to) barium and potassium in efforts to raise Tc to the levels achieved during 1987/88 in the cuprates. (Of course, it would be welcome news if further developments of bismuthate SCs retain the new isotropic equi-directional characteristics of the first-discovered AT&T bismuthate compound.)

The history of the new development is interesting. It is along lines explored in the 1970s by Arthur W. Sleight of Du Pont. His paper, published in the July 1976 issue of *Chemical Technology,* discussed several metal-oxide superconductors, including barium bismuth oxide.

Sleight also explored barium lead oxide, cadmium osmium oxide, and others. He found SC only at extremely low temperatures, generally about 4° K or lower. However, he listed a Tc of 14° K—high in 1976—for lithium titanium oxide. At the conclusion of his paper, he essentially predicted the results that have occurred in the last two years.

The AT&T work is described in the April 28 issue of *Nature.* The paper lists the formulations tried during the development of the barium potassium bismuth oxide material. In this list, rubidium is shown to be almost as good as potassium; it has a Tc of 28.6° K instead of 30° K.

As described by Cava and his coauthors in *Nature,* the volatility of the alkali oxides—potassium or rubidium oxide—was overcome by containing and processing the ingredients in sealed silver tubes. These tubes were then held for three days between 425° to 475° C. Many such experiments yielded the best compound.

Solutions Prevent 1-2-3 Degradation

Despite the emergence of new HTSC compounds using bismuth and thallium, rare-earth-based copper-oxide materials continue to be widely produced and sold. Indeed, based on our conversations with materials producers, more 1-2-3-based HTSC material is sold than all of the others combined.

The 1-2-3 compound is easy to fabricate, fairly simple to process, and presents few hazards to the producers or users (unlike thallium, which is a deadly poison). The bismuth-substitute copper oxide requires far greater precision than the 1-2-3 compounds in heat treatment. The critical range of the final annealing temperature to produce the highest grade HTSCs is only several degrees Centigrade out of 850 to 900 in the bismuth material, compared to 30° in the 1-2-3 compound.

"If you hold your tongue on the side of your mouth enough to change the temperature three degrees, you may lose superconductivity" with bismuth-substitute materials, says Bud Cass, president of HiTc Superconco, a Lambertville, N.J., HTSC materials producer, only half-jokingly, to explain his exasperation.

As popular as the rare-earth cuprates remain, they, too, pose difficulties: they lose oxygen and are sensitive to moisture. In either condition, the compound's SC properties degrade, sometimes enough to render it useless. Many groups are seeking to develop processes to protect the 1-2-3 compounds from these twin problems.

Our June issue reported briefly on a process developed by Fujitsu in Japan, where a

hydrofluorocarbon gas, CHF_3, is polymerized (made into a plastic material) directly on the HTSC ceramic's surface.

The 1-2-3 compound, after being final-annealed and adjusted to optimum oxygen content, is inserted into a radio-frequency plasma developed in gaseous CHF_3. Its molecules join together (polymerize) directly on all surfaces of the 1-2-3 ceramic. The resulting film of plastic material is bonded tightly to the ceramic and prevents moisture and oxygen from entering or leaving the HTSC compound. It then apparently retains its SC properties as a stable product.

A second process has evolved at Energy Conversion Devices Inc. of Troy, Mich., as a valuable side-effect of its research into fluorine as a partial substitute for oxygen in the 1-2-3 material.

Last fall, the company announced that introducing fluorine into the yttrium-barium-copper-oxygen material produced signs of dramatically increased Tc—the temperature at which zero electrical resistance is reached. It claimed indications of Tc at temperatures as high as 165° K.

Rosa Young, director of the company's SC group, now says that fluorine is useful in several directions. Young says that fluorine continues to elevate Tc in the 1-2-3 compound by about 3° K overall. Minority components in the fluorine-treated material continue to show evidence of SC in the 150° K region, she adds.

Equally important, the fluorine appears to protect against oxygen loss and moisture degeneration, Young notes. She points out that a very thin layer of barium fluoride is formed on the exterior surfaces of the fluorine-treated 1-2-3 ceramic. This layer stabilizes the material against the effects of moisture and temperature cycling, in which oxygen levels ordinarily can decrease.

Responding to the question, "How much fluorine?" Young says that replacing 3 percent of the oxygen with fluorine is optimal. An excess of either fluorine or oxygen reduces Tc. With the proper amount of both as close as possible to O_7 in the $Y_1Ba_2Cu_3O_7$, and fluorine replacing 3 percent of the 0_7, the compound achieves Tc about 3° K above the best 1-2-3 compound—and it is not degraded by moisture, nor does it lose oxygen.

COMPUTERS

COMPUTER Daily

Consortium Unveils Supercomputer

Scientists at the John von Neumann National Supercomputer Center have unveiled the ETA10 supercomputer, the most powerful computer installed in the world, according to the center.

The four-processor supercomputer will be used by over 1,300 researchers and scientists at more than 100 institutions throughout the country to advance scientific discovery in fields ranging from aerospace engineering to oceanography to molecular modeling. The machine was produced by ETA Systems Inc., a Control Data Corp. subsidiary based in St. Paul, Minn.

Established in 1985 with $69.2 million from the National Science Foundation and a $12.1-million grant from the New Jersey Commission on Science and Technology, the von Neumann Center is one of only five national supercomputer centers in the United States. It is managed by the Consortium for Scientific Computing Inc., a group of 13 academic institutions including the University of Arizona, Brown University, the University of Colorado, Columbia University, Harvard, the Institute for Advanced Study, the Massachusetts Institute of Technology, New York University, Pennsylvania State University, the University of Pennsylvania, Princeton, the University of Rochester at Rutgers, and the State University of New Jersey.

"The von Neumann Supercomputer Center today is one of the premier centers for advanced scientific research in the United States and throughout the world," says Doyle D. Knight, president of the consortium and a Rutgers University aerospace engineering professor. "The addition of a supercomputer as powerful as the ETA10 will help us retain that leadership position and attain several critical goals."

Knight noted that the first and foremost goal is to drive more research through the center. "By expanding the computational power of our facilities in raw speed and scope, we intend to inspire researchers to tackle a new genre of complex problems only supercomputers can effectively solve," he says.

In the past two years, more than 185 scientific papers written by the center's users have been published or accepted for publication.

"The second goal," Knight says, "is to advance the state-of-the-art in visualization in scientific computing. Scientists working at 3-D graphics workstations linked to the ETA10 supercomputer will literally be able to steer their computations as they run them. By interacting with data in such a timely manner, researchers will gain additional insight into their respective sciences, whether oceanography or molecular modeling."

Knight noted a third goal of increasing technology transfer through greater participation by the private sector in the center. Firms already taking advantage of the center's supercomputing services include Ciba-Geigy, Dynalysis, Exxon, and Princeton Forecasting.

The ETA10 is one of five Model E machines installed around the world. It has immense computational power and throughput capability. The machine's peak performance is rated at over three billion floating-point operations per second, which is eight times faster than the performance of the two Cyber 205 supercomputers the ETA10 replaces. Each of the four central-processing units has 32 million bytes of local memory and one billion bytes of shared memory.

A series of upgrades planned for later in 1988 and 1989 will double the machine's memory capacity and more than triple its throughput. Facilities that augment the ETA10 supercomputer include front-end computers and workstations, computational and graphics software, a sophisticated high-speed network, and expert consulting from staff.

INTERNATIONAL COMPUTRAN CORPORATION TEC REPORT

NEC Is First to Offer Neurocomputer

Nippon Electric Co. (NEC) has announced the development of a personal neurocomputer that will be commercially available in December.

Touted as the industry's first commercially available neurocomputer, the system is priced from $5,440 (680,000 yen) for a minimum configuration to $11,198 for the largest system, which includes a PC9800 computer, display, boards, and software.

The computer consists of the PC9800 personal computer, a neuro engine board, and a neural-network program with learning capability. With this new computer, software-development tasks for character-recognition systems, expert systems with learning capability, voice-recognition systems, and robot control systems can be completed in about one tenth the time required by conventional computers.

The neuro engine board incorporates four data-flow type microprocessors (MuPD7281) which are used to perform high-speed parallel processing. The maximum number of neurons (actually semiconductor memories) is 82,000, with 246,000 neuron couplings. The neurocomputer provides a maximum execution speed of 216,000 links per second.

The arithmetic processing capability is rated at about the same level as a minicomputer system. NEC noted that in an alphanumeric character-recognition system, the computer is capable of recognizing 99.95 percent of characters in 76 types and fonts. The neurocomputer can also "learn" characters in 1/40th of the time required by conventional personal computers.

BIOTECHNOLOGY

APPLIED GENETICS NEWS

Oncogene Products Found to Control Genes

Scientists at the University of California in San Diego have confirmed for the first time that a protein produced by an oncogene can bind to human DNA and directly control the activity of other cellular genes.

The discovery was made while the research group studied the human metallothionein 11A gene, which is believed to be involved in the regulation of zinc metabolism. Thus, this gene may be essential for normal cell growth.

The researchers defined a region of DNA that controls the gene's activity, then searched for proteins that bind to this DNA region. They

identified several proteins that initiate gene transcription—the copying of the genetic message in a form needed for the cell machinery to make proteins.

One of these transcription initiators, called API, is coded by a gene that was found to have an amino acid sequence very similar to that of the cellular counterpart of a known viral oncogene called jun.

This is one of the first examples of a well-documented transcription factor that has been shown to act as an oncogene. Scientists have long suspected that both growth and cancer involved the activation of genes, or a change in the activity of genes. Oncogenes have been found to be associated with the abnormal or excessive production of growth factors and the cell membrane receptors that respond to these factors.

Oncogenes have also been linked to the production of the signal chemicals that deliver the growth message to the cell nucleus. The research reveals that oncogenes can be involved in every single step of the normal growth process. API is stimulated by normal growth regulators as well as by tumor promoters. API also stimulates the gene that codes for the enzyme collagenase. This enzyme digests connective tissue and is important in the process of wound healing. Collagenase, however, may also help tumors invade healthy tissues.

Molecular biologist Michael Karin, who led the research group in the discovery, believes that factors such as API activated the genes that code for growth factors and other chemicals involved in growth control. These growth chemicals then stimulate even more API production, resulting in a vicious, self-sustaining cycle of cell proliferation that leads to cancer.

Karin thinks that by studying the mechanism of the process, scientists may be able to design better strategies to restore the growth-control process and prevent the proliferation of tumor cells.

LASERS

LASER REPORT

Air Force Fires New Laser, May Use It in Star Wars Program

A military excimer laser fired for the first time at the White Sands Missile Range in New Mexico marked a milestone in high-power-laser technology.

The Excimer Moderate-Power Raman-Shifted Laser Device (EMRLD) was developed by the Air Force Weapons Laboratory at Kirkland Air Force Base in New Mexico. The program is sponsored by the Strategic Defense Initiative Organization (SDIO) and the U.S. Air Force Systems Command.

The EMRLD produces a very bright and destructive beam of light that will travel extremely long distances. This could make it an ideal ground-based laser weapon for attacking targets in space, either directly or beamed off orbiting mirrors.

According to Lt. Col. Eric Jumper, EMRLD project manager, "During last month's test, EMRLD produced pulses of light lasting about one millionth of a second each, with energies of 15 to 20 J at a wavelength of 0.35 meters. We also operated all the components together as a laser system.

"This was a critical milestone towards our goal of producing average powers in excess of 5,000 watts while pulsing the laser 100 times per second. We hope to complete full-power tests of the system by this fall, at which time it will be the largest repetitively pulsed excimer laser in the free world. Obviously, years of development are still needed to create a weapon based on this technology," he concluded.

FIBER OPTICS

Fiber Optics News

GTE Develops Amplifying Fiber Laser

GTE Laboratories has developed the first laser made of a new type of optical fiber that can amplify at 1,300 to 1,340 nanometers, the principal transmission wavelengths currently used in standard fiber-optic telecom systems. To develop the amplifier, GTE scientists William Miniscalco and Leonard Andrews used optical fiber made from neodymium-doped fluorozirconate, which is an oxygen-free glass.

"The new device opens up options for advanced telecom systems design," Miniscalco said. "We believe that fluorozirconate fiber may have a very important role in the development of LANs and subscriber loops. Because the electronic repeaters currently used are costly, this could be a viable and inexpensive means for amplification. In applications where expensive electronics are not needed, a fiber device could provide the boost and give much more flexibility and freedom for systems designers. An inexpensive amplifier such as this can boost signal levels sufficiently to send information to as many as 100 times more subscribers than can be reached by unamplified signals."

The researchers stressed that, beyond its potential uses, the amplifier, still under development, is significant for its choice of materials. "In an all-fluoride glass, the electronic properties of neodymium are altered so that the strength of the loss mechanism is reduced, allowing the gain process to dominate," Miniscalco said. "Silica technology is well developed, but fluorine technology is not. The principle of this has been effectively demonstrated, but work has to be done to characterize the fiber for single-mode uses."

Miniscalco and Andrews are optimistic about fluorine fiber's potential. "In some ways, this is competing with the semiconductor laser amplifier," said Miniscalco, "but a fiber amplifier has the advantages of matching the transmission medium, and it doesn't have the insertion losses of planar waveguide devices. Also, the signal-to-noise ratio should be better with a fiber device.

"But basically, this all comes down to practicality. There's a worldwide interest in single-mode fluorine fiber. Once the technology can be mastered, doping can be easily achieved. In two years or so, it should be easy and inexpensive to produce.

"This is superior at 1,300 nm and there's an experimental basis that it's superior at 1,550 nm as well, but much work is required and there are many labs taking the same approach. We like to delude ourselves that at GTE we have the answers, but we do feel we have a real basis for saying that fluorine fiber will prove to be superior to silica-based fiber."

Fiber-Optic Missile Overcomes Army Resistance

When he first proposed building a fiber-optic missile in the early 1970s, inventor William Culver had a hard time convincing the U.S. Army to change its ways. For one thing, Culver's missile threatened to shake up the way the Army did business.

According to Culver, his proposal encountered resistance because there was no military requirement for the weapon at the time. In addition, because his missile enables the infantry to kill tanks from a distance of more than 10 kilometers, he was threatening artillery missions.

"Tanks, artillery, the mode of operation of the infantry and helicopters are all in jeopardy if you develop, not just one fiber-optic missile, but a whole family of fiber-guided devices," said Culver, currently the president and chief executive officer of Optelecom, a company based in Gaithersburg, Md. Culver presently holds the patent for the fiber-optic missile.

The key element of the missile's technology is a fiber-optic cable. The cable unwinds behind the missile after it is launched, providing a link between the guidance system and the ground station. The missile is guided from the ground by a gunner who monitors video images projected onto a television screen by the missile.

Previously, the missile's distance capabilities were limited because the fiber-optic cables were only two to three kilometers in length. This has been greatly improved, according to Culver, who claims that the new fiber-optic links can go 200 to 300 kilometers.

The program, however, owes its existence to the fact that the missiles are capable of shooting down hovering helicopters. Without this capability, the Army would have never launched the program, said Culver. The missile's ability to bring down helicopters was demonstrated in the wake of the Pentagon's 1985 cancellation of the Sergeant York Air Defense gun.

Since the demonstration, the missile has gained support, and is now part of the Army's $11.6-billion Forward Area Air Defense program.

Culver feels his invention is important because it could help the military overcome "the tremendous disadvantage U.S. forces face on the ground in Europe because Soviet tanks and artillery far outnumber ours."

In 1972 Culver established Optelecom, following disappointing responses to his proposal to develop the missile. Along with an IBM colleague he hired, Culver began producing the weapon in his basement.

The patent, which was issued in 1976, covers two methods of guiding missiles. Retroreflectors—devices that reflect light back directly to the source—are covered by the patent, in addition to the fiber-optic link.

Optelecom has completed a study of the possible applications of this technology for the Army, and has received a Navy study contract. Also on the company's agenda is the development of data links capable of transmitting as many as three television images back to a command post and about 20 channels in the opposite direction. Optelecom is working on various air and ground robotics programs. In addition, it has a $6.2-million contract with the Army Missile Command for general technology support of various programs, including FOG-M.

FOS²
Fiber Optic Sensors and Systems

Advance Made in Fiber Coil Winding

The inherent advantages of the optical fiber current sensors based on the Faraday magneto-optic effect are well known. The ultimate potential of this kind of sensor, however, depends on the availability of high-performance, low-cost fiber coils.

Unfortunately, the fiber coils fabricated using the present techniques have some disadvantages. These disadvantages include:

- The stress-induced birefringence in these coils leads to a decrease in sensitivity and to problems with calibration and stability, especially a temperature sensitivity dependence.
- There is a difficulty with increasing the number of turns and reducing the size of coils, and thus no compact and high-sensitive fiber current sensors have been developed as of yet.
- These coils require expensive, special fibers, such as spun fibers and helical fibers, thus keeping the cost high.

These disadvantages are a major impediment to the development of high-performance, low-cost fiber current sensors.

A recent breakthrough in overcoming these difficulties has been made at the National Bureau of Standards' Boulder Laboratories. Dingding Tang, a guest scientist with the Electromagnetic Technology Division of the NBS Optical Electronic Metrology Group, has fabricated fiber coils with the following advantages:

- The stress-induced birefringences in the coils, which will lead to less sensitivity and to problems with calibration and stability, were eliminated.
- A fiber coil with 200 turns and a diameter as small as nine millimeters has been obtained and, according to Tang, a further increase in turn number as well as a further decrease in coil diameter will be possible. These kinds of fiber coils should allow the construction of fiber current sensors that are more sensitive (only a few microamps or less), compact, and more stable than previously possible. Their small size makes them very attractive for special applications such as fusion plasma diagnostics and testing the impact of nuclear explosion on electronic circuits. Moreover, the short length of fiber employed in such small coils allows high bandwidths owing to the reduced optical transit time.

AEROSPACE

militarySPACE

Pegasus: Booster and Weapon in One

The Pegasus air-launched lightsat booster from Orbital Science Corp. (OSC) could be used for more than just payload launches. According to OSC, the system could also provide military commanders with the ability to knock out targets anywhere on the globe.

The B-52-launched booster can provide U.S. military commanders with a worldwide capability for "responsive ordnance delivery." In a presentation to Defense Dept. officials, OSC said the winged vehicle would give field commanders the

ability to strike with "stealth" at ships and bases thousands of miles away.

Designed with technology used in state-of-the-art tactical and strategic missiles, Pegasus would need a launch crew of only 10 persons. Without the need for fixed launch pads, the vehicle could provide "'rapid call-up and quick turnaround" from numerous airfields around the world.

In addition to weapons delivery, Pegasus could provide reconnaissance lightsats with "first pass coverage of any point on Earth." OSC plans to launch its first payload for the Defense Advanced Research Projects Agency lightsat program by next summer. Each three-stage booster will cost less than $10 million.

Lightsat applications could include surveillance, radio frequency relay, and ordnance targeting. A single Pegasus carrier plane could launch up to four payloads per day. Such a capability would let U.S. Space Command augment or replace satellites during a conventional or nuclear conflict.

OSC's briefing on Pegasus' "unique operational attributes" describes exactly the kind of system favored by many Pentagon strategists. In a recent report entitled *Discriminate Deterrence,* a blue-ribbon commission on long-term military strategy urged intensive work on long-range, high-accuracy "smart" munitions.

The bipartisan commission, chaired by Fred Ikle and Albert Wohlstetter, noted "extraordinary" advances in weapons-guidance technology. The commission said current technology makes it possible to attack fixed targets at any range within one to three meters. "These accuracies and modern munitions give us a high probability of destroying a wide variety of point and area targets with one or a few shots without using nuclear warheads," the report says.

Although shorter-range munitions could play a major role in deterring Warsaw Pact attacks on Western Europe, the commission said long-range delivery systems will be "increasingly necessary" for the Asian and Pacific theater. "Given the growing importance of [the Pacific] theater, the Pentagon should look ahead by choosing systems with ranges significantly beyond those needed in the European theater."

For surprise attacks, OSC says Pegasus could be launched in southward "retrograde" orbits for "passing shot" attacks from unexpected directions. Pegasus could also launch the Air Force's hypervelocity glide vehicle, which may eventually replace MX ICBMs. OSC also suggests the vehicle could be a target for SDI tests.

OSC also advances Pegasus as a test bed for the National Aerospace Plane. Last year, members of the Defense Science Board recommended testing NASP's supersonic combustion ramjets on an unmanned hypersonic vehicle.

As the first high-speed aerospace vehicle developed without wind-tunnel tests, Pegasus will also pave the way for NASP's manned X-30 research vehicle. OSC says all its pre-flight aerodynamic and aerothermodynamic tests will be done in a "computerized wind tunnel" with computational fluid dynamics (CFD) techniques.

OSC and Nielsen Engineering and Research Inc. of Mountain View, Calif., plan to do Pegasus CFD work on Cray-2 and Cray XMP supercomputers at NASA's Ames Research Center. OSC says Pegasus flight tests also will serve as a "real world testbed" for Ames' CFD codes over a wide range of airspeeds and air densities. The Ames Numerical Aerodynamic Simulator plays a major role in development of NASP's manned X-30 research vehicle.

Computerized simulations are not the only advanced feature employed in Pegasus. The vehicle also uses some of the most recent advances in solid propulsion, materials, and avionics. All three stages will use graphite fiber casings developed by Hercules for trident D-5 and MX missiles.

Stages will burn hydroxil-terminated polybutaidiene-based propellant used in Pershing 2 missiles. Additional lift during the first-stage burn (from 40,000 to 200,000 feet) will come from a graphite composite delta wing built by Scaled Composites Inc. of Mojave, Calif.

Attitude control during the first-stage burn, which will accelerate the vehicle from Mach 0.8 to Mach 8.7, will be provided by aerodynamic fins. Gimballed nozzles and a cold-gas reaction control system will control the vehicle at altitudes above 200,000 feet.

The fins and thrust vector systems will be controlled by a ring laser gyro-based inertial guidance system. Pegasus avionics will also use 14 microprocessors for vector processing and preflight checkouts. These systems will permit assembly and checkout with only 10 people and a single ground-support trailer at the departure airfield.

How will OSC combine all of these state-of-the-art

systems into an integrated system within 28 months? The company says it formed a "skunk works" development team of 80 persons at OSC, Hercules, and several key subcontractors.

"The team is using a development approach that emphasizes high design margins on advanced technology components and an experimental shop assembly and test approach to reduce development cost and time," an OSC fact sheet says. "To supplement ground testing of the vehicle, qualification by flight will be used to refine actual performance and accuracy."

ARTIFICIAL INTELLIGENCE

Advanced
MILITARY COMPUTING

Neural Nets Attract Attention and Money

Three or four contracts worth several million dollars to expand neural-net research will be awarded by the Air Force soon. The Air Force's interest in the new technology resonates with planned increases in neural-net funding by the Defense Advanced Research Projects Agency.

The contractors will explore using neural nets, computer programs that "learn" or " adapt" to their environment, for aircraft-control applications. They will also explore robotics for manufacturing, and join with General Motors in the Dayton area for additional research.

The flight-control system will allow the airplane to reconfigure itself when controls are damaged. It is known as a self-repairing flight-controls program.

There is other work—although not necessarily in the Air Force—in the automatic evasion of missiles. If the pilot will trust the system, it is expected to recognize a missile has been fired, calculate the direction from which it was fired, and make the best maneuver for the aircraft, based on experience.

Neural nets are also of interest to the Air Force for signal processing and image understanding.

"This past year has seen a blossoming of commercial enterprises that are dedicated to doing neural networks," said William Baker, chief of the Artificial Intelligence Applications Office at Wright-Patterson Air Force Base in Ohio. Texas Instruments is also active in neural-net exploration.

"There was an IEEE-sponsored (Institute of Electrical and Electronic Engineers) neural-net conference in San Diego last year that was a watershed for neural-network research. About 2,000 came. The year previously they had a workshop and only 500 attended. In the past year since that conference, 10 to 20 companies have sprung up dedicated to neural-network products and programming," he said. The firms sell both software and hardware. One of the leading firms, based in San Diego, is Hecht-Nielson, he said. It was formed by former TRW employees.

"If neural nets can learn and retain what they learn as well as theory says they will, they will certainly have a place in weapons systems and in commercial [applications]," he said. "The Defense Advanced Research Projects Agency has just started a large program in neural-net research, and Hughes, TRW, and Boeing are seriously doing neural-net research."

COMPUTER Daily

Electronic Publishing to Combine Hypermedia and AI

The convergence of hypermedia, artificial intelligence (AI), and electronic publishing technology is producing an important new direction for publishing called "hyperpublishing," a hybrid technology that represents a multibillion-dollar opportunity for system and software developers.

Hypermedia is non-linear text, graphics, and imagery that combines a database method, a knowledge representation scheme, and a human interface modality. The concept is quite simple: windows on a display screen are associated with objects in a database, and links are provided between these objects.

AI attempts to make electronic publishing systems more useful by making them handle publishing tasks in a way that, if people were solving these problems, you would call these people intelligent. Four key areas of AI are important to electronic publishing:

- speech—recognition and synthesis of human speech,

• vision—recognition and rendering of text, graphics, and imagery,
• natural language—understanding the generation of spoken, written, and visual communication, and
• expert systems—knowledge representation, learning, reasoning, and planning.

The impact of hyperpublishing technology over the next decade will be broadly felt in four ways. It will redefine the nature of tools for authoring, design, and communications art; transform publishing processes; introduce new media and new forms of publishing; and engender new (global) literacy environments for research, collaborative authoring, publishing, and use of information.

Practical applications of hypermedia and artificial intelligence in electronic publishing are an established fact in the marketplace. The scope of these applications is impressive: speech recognition, text scanning, graphics recognition, natural language interfaces, hypermedia and expert systems for authoring and design, idea processors, intelligent search and retrieval, precis writers, automatic document generation, expert systems for printing and publishing management, networked literary environments, and much more.

The outlook is for rapid development. Market interest is growing, especially now that personal computers make viable platforms for AI and hypermedia-based applications. The number of hyperpublishing-related projects, and the level of investment in them by corporations, government agencies, and commercial publishing organizations is rising sharply. The number of vendors developing hypermedia and AI-based tools for publishing and the pace of new-product introductions is also increasing.

TELECOMMUNICATIONS

THE SPANG ROBINSON REPORT ON
Artificial Intelligence

VAX Computers Beat Cray in Super Network

Combined research talents from Yale University, Scientific Computing Associates (SCA) of New Haven, Conn., and Sandia National Laboratories recently produced significant results in what may be the ultimate in remote distributed computing. Using the software package invented at Yale by David Gelernter and associates in the Linda Project, and commercialized by SCA, Sandia scientists implemented real-life applications software distributed among several VAX systems connected to the Sandia network.

The results for one such application, a rocket-plume analysis program, showed performance for 14 VAX processors working in parallel to be twice as fast as Sandia's Cray 1 processor.

The VAX processors are linked in a configuration called Supernet. They are located physically in both Livermore, Calif., and Albuquerque, N.M.—more than a thousand miles apart. The Linda software system lets developers design applications for parallel computers without regard to the underlying computer architecture. The designer can concentrate on designing while Linda coordinates the various parts of the computation, Sandia spokesmen said.

The work at Sandia was directed by Robert Whiteside, program manager for Supernet. In addition to the rocket plume application, Whiteside converted a semiconductor device problem from the Cray 1 to an eleven-VAX Supernet configuration. This problem ran in 74 minutes on the Cray, and 151 minutes on the Supernet, a significant improvement in cost/performance. For a thermal-analysis application, however, Supernet achieved only six percent of Cray performance, reflecting large communications overhead involved in processors exchanging data.

Joe Harris, supervisor of applied mathematics at Sandia Livermore, said, "The performance results of the thermal-analysis program demonstrate the limitations of this type of parallel processing. Many applications will run poorly on the network."

The goal of the work is not to try to exceed supercomputer performance, but to achieve supercomputer capability by fully using existing minicomputers. The system allows Sandia to use its computers around the clock.

The Linda software easily enables the VAX computers to run in parallel. Further, using Linda means codes must be converted to parallel use only once. William Wilson, manager of computation at Sandia Livermore, said codes don't have to be redone for every new computer or configuration. "Once the codes are parallelized," he said, "Linda does all the rest."

Coal & Synfuels Technology

EPRI Sees Growth in Combustion Turbine Use

Scorned in the past as unreliable, combustion turbines will form the linchpin of new utility power plants in the future, according to the Electric Power Research Institute (EPRI).

"On the order of 2,500 Mw of combustion turbines have been ordered in the last year, and that could grow to 5,000 Mw in a year or two," says Ron Wolk, a director in the institute's advanced power systems division, in the most recent issue of *EPRI Journal.*

Dwain Spencer, EPRI vice president of advanced power systems, predicts that as much as three-fourths of the next 100,000 Mw of utility generating capacity to come on line in the United States will be based on gas turbines. "We see over 45 Gw of indicated—but largely unannounced—orders for combustion turbine capacity over the next 12 years already, and I'd be amazed if that figure isn't over 55-60 Gw by 1990," Spencer says.

Without improved combustion turbines, gasification combined-cycle power plants wouldn't be possible. Many utilities looking at combustion turbines are doing so as part of their consideration of phased-in coal gasification, combined-cycle systems. That's why EPRI has funded research to improve their performance.

The original combustion turbines were derived from early jet aircraft engines. These pad-mounted versions were relatively inexpensive to construct, but they could burn only premium fuel, so they were used as peaking units.

Because of their limited use, combustion turbines weren't maintained rigorously, and that led to even lower reliability, EPRI says.

But turbine manufacturers—in some cases with EPRI funding—have made such great improvements that utilities are becoming more interested in combustion turbines, Spencer says. Uncertainty over future oil and natural-gas prices also has rekindled utility interest in combustion turbines, he says.

"The new turbines are much more mature in design and can be fired with oil, natural gas, or now even gasified coal," says Spencer. A utility can install combustion turbines for peaking capacity in as little as two years. As demand rises, the utility can add heat-recovery steam generators for baseload power.

The heat-recovery system increases efficiency and plant output by using the combustion turbine's exhaust heat. As gas prices rise, the utility can add a coal gasifier, which also adds to capacity.

As long as natural-gas prices stay less than $6/mmBtu, gas-fired plants make the most sense, EPRI says. A gas turbine can be installed for $300/kw; adding equipment for a combined-cycle plant increases the cost to $600/kw.

Natural gas prices currently stand at $2 to $3 per mmBtu, and those prices could double before the life-cycle cost of a combined-cycle plant would exceed that of a coal-fired plant, the institute says.

EPRI is demonstrating an integrated gasification, combined-cycle system at the Cool Water plant in Daggett, Calif. The plant uses an 80-Mw General Electric 7E turbine, which has broken down only seven times in nearly four years, EPRI says. That failure rate is a vast improvement over past performance, and turbine manufacturers are aiming to achieve even better.

Aircraft-engine research for the Defense Dept. also led to improvements in modern combustion turbines. General Electric, Siemens-Kraftwerk Union, Asea Brown Boveri, and Westinghouse are offering machines rated at 70 to 100 Mw—up to 10 times larger than the first combustion turbines.

Manufacturers were able to build larger, more powerful, and more efficient models by raising the design fuel-firing temperature at the combustor outlet. Current models have firing temperatures of about 2,000° F with full-load, simple-cycle efficiencies of about 32 percent.

In addition, EPRI expects all four manufacturers to offer turbines rated at 135 to 150 Mw with firing temperatures around 2,300° F and efficiencies of 35 percent. In a combined-cycle configuration, efficiencies would increase to 45 to 47 percent.

General Electric is the first to go into production with the larger unit; the first GE 135-Mw 7F model will be installed at Virginia Power's Chesterfield station later this year.

Unfortunately, Spencer says, hotter firing temperatures can themselves challenge reliability and require sophisticated on-line diagnostic devices and advanced cooling techniques.

Researchers Probe Coal-Fired Heat Engines

Researchers are looking for ways to burn cheap coal in gas turbines and diesel engines, but the cost of machines that can withstand the harsh materials in coal could eat up the savings and then some.

That is the dilemma facing industry researchers: whether to go to the expense of cleaning coal to protect engine parts, or to modify the engines extensively to burn dirty coal—an even more expensive proposition. After preliminary studies, it is clear that tradeoffs will have to be made, said government officials and contractors gathered recently in Morgantown, W.Va.

Of the two options, it is more desirable to keep coal cheap because low fuel costs will make the systems more economic in the long run, said John Wilson, assistant director of the Morgantown Energy Technology Center (METC), which is managing two contracts for coal-fired diesels and four contracts for gas turbines.

But making expensive engines isn't desirable either, and economics will be an important factor as the six contractors continue their work, Wilson said.

In addition to finding the right fuel and durable parts, emissions also could be a problem. Even though there aren't regulations covering coal-fired heat engines or diesel locomotives now, regulators surely will take notice once the machines are marketed, Wilson said.

METC is looking at hot-gas cleanup systems that would clean particles out of the coal gas before it goes through the turbine blades. The systems would protect equipment as well as control emissions, but could be prohibitively expensive. Hardening the blades and cleaning up emissions downstream is one alternative researchers are examining.

The idea for coal-fired heat engines isn't new. Tests done in the 1950s and 60s showed that the concept basically worked, but there were so many problems that many researchers gave up. Work continued throughout the 1970s, but then was nearly killed when the Reagan administration took office and attempted to gut the Energy Dept.'s fossil-fuel research program. Project teams regrouped, and DOE's current heat-engines program evolved.

With new developments in materials and fuel-cleaning technologies, researchers in the 1980s have started finding new solutions to the old problems. METC in-house researchers and outside contractors are pursuing a new line of advanced coal-fired gas turbines with higher firing temperatures and increased efficiency.

Among the programs under way:

■ **Solar Turbines Inc.** of San Diego plans to conduct a full-scale test using coal slurry in its existing Centaur Type "H" gas turbine. The company, a subsidiary of Caterpillar Inc., has just arranged the $2.8-million in capital investment it needs to upgrade the facility where it will run the test. The company will modify the turbine slightly to run on coal and is developing a two-stage slagging combustor. The system is being developed for industrial cogeneration.

Preliminary tests will concentrate on components, with testing of the integrated system planned for 1990. Work so far has provided Solar researchers with an indication that emissions from the combustor will meet current environmental standards, particularly for NO_x, without any downstream cleanup, the company said.

■ **Westinghouse Electric Corp.** also is developing a two-stage slagging combustor as part of its six-year program to develop and test a 0.5-Mw coal-fired gas turbine and a commercial-scale prototype for a 100-Mw Westinghouse gas turbine suitable for a combined-cycle utility power plant. The company planned to start a 15-month pilot test in August at Avco Research Laboratory's Haverhill facility.

■ **Allison Gas Turbines Division** of General Motors this fall will complete a two-year pilot-scale test of components, and then start a two-year, full-scale test of components and a complete proof-of-concept test of the integrated system. Allison's technology includes a slurry-fueled, rich/quench/lean combustor system with a slightly modified Allison 501-KB5 industrial engine. The company will work with coal-slurry suppliers to develop the fuel and examine how different fuel composition and turbine-blade coatings affect erosion and corrosion.

So far, the company has developed a fuel nozzle it says provides the fine spray needed to get complete combustion. It began tests last week of a pilot-scale combustor, which includes a compact, high-efficiency inertial particle separator to remove particulates.

■ **General Electric** is developing a 3.8-Mw system using its LM500 turbine, derived from a jet engine. The system can be used for small power plants and transportation applications such as locomotives, but probably will be better for cogeneration.

GE is looking for harder materials that are cheap but stand up to coal, especially in the fuel-injection system, and also is evaluating different emission-control processes. Bench-scale tests have shown that adding clay to the coal-water mixture reduces ash deposits on the turbine blades. In addition, adding lime to fuel removes 60 percent of the SO_2. But GE found that the addition of lime resulted in SO_2 downstream by conventional means. GE researchers also are looking at a high-temperature, high-pressure baghouse to collect ash.

■ **GE Transportation Systems** of Erie, Pa., is just starting work under its second contract with METC for coal-fueled diesels. In 1985, the company undertook a $2-million program to develop a fuel-injection system for coal-water mixtures and to run an engine on the fuels. GE received an additional $1 million to continue the work, which is near completion.

Researchers developed a nozzle with good atomization, and now are working on durability. Coal particles erode the small holes in the nozzle, so GE is trying superhard materials such as diamond compact and cubic boron nitride. The company also is trying different materials such as high-quality tungsten carbide to improve the durability of rings and liners.

Under its second contract, awarded in March, GE plans to develop a multi-cylinder, coal-fired diesel engine for a locomotive. Under the $21-million program, GE expects to install an engine in a test-bed locomotive within two years and demonstrate a commercial-size prototype within five years. At the same time, GE will continue to improve its fuel-injection and emission-control systems. Norfolk Southern Corp., the Pennsylvania Energy Office, and the New York Energy Research and Development Authority are cosponsoring the project.

GE's Paul Flynn said part of the program involves developing a stable, easy-to-handle coal-water fuel with consistent viscosity for a medium speed; and for all of that, it must be cheap. Program managers have started collecting samples from slurry suppliers in preparation for fuel development, and researchers are drawing up preliminary conceptual designs for a locomotive.

■ **Arthur D. Little Inc.** is working with Cooper-Bessemer, AMBAC, AMAX, and Battelle on a five-year program to develop a multi-cylinder coal-fired diesel engine for industrial applications. The project team also has found nozzle and ring wear to be high, and is looking at alternative materials. Emissions data so far show that NO_x levels are low compared to regular diesel fuel. Particulates, however, have been a problem. Arthur D. Little, based in Cambridge, Mass., also will be looking for a way to make the coal-water fuel cheaper.

MANUFACTURING AUTOMATION

Flexible Automation

Allen-Bradley Unveils CIM System

Allen-Bradley is now beginning to show the world its Twinsburg, Ohio, surface-mount technology (SMT) device line. It is one of the most exciting facilities yet shown to the public. Allen-Bradley has gone to great lengths to develop a total computer-integrated manufacturing (CIM) system. It envelops not only automated production of boards but also integration with high-level business planning computers, remote CAD systems and, vendors.

The environment is heterogeneous. Linked together are Tandem, DEC and IBM computers, Panasonic SMT assembly equipment, and an Adept robot along with Allen-Bradley's Vista 2000 cell control and complement of PLCs. Information courses over DECnet, TCP/IP, and Allen-Bradley's Data Highway. The facility is a microcosm of how factories will soon operate—integration will be extended to other activities at Twinsburg and probably elsewhere at Allen-Bradley.

Twinsburg addresses a difficult set of problems: to produce high variety in low volume. A new board comes along about every two days and an engineering change order every few hours. Boards range in size from 2.3 inches to about 17 inches on a side and are produced in relatively small quantity (17 is the average production run). They must be produced economically, no matter how few of each are required.

A number of fundamental approaches contribute to success. One is focus on database technology. Another is to interface machines and controls in ways to minimize the amount of required custom code. Important, too, is the near demolition of

barriers between engineering and manufacturing. The two functions which normally occur sequentially occur simultaneously, with care given to manufacturability of the boards.

To a degree, Twinsburg is a product of well-informed faith. At the outset, financial planners could not produce a report that unequivocally measured the benefits of investing $2.5 million for equipment and $1 million for integration to build the flexible facility. Measuring tools simply are not available, although the financial and accounting staffs are now working hard to develop such tools. The proposed facility was subjected to conventional ROI and other formulas. As it turns out, conventional measures account for only about 50 percent of the benefits. The benefits of information integration include:

- Board-assembly time has been cut from 15 days to one.
- Engineering change orders that took one to three weeks to implement now take two to three hours.
- The engineering to manufacturing cycle has been cut from 52 weeks to 26 weeks.
- Vendors are cutting part-fabrication time from 20 weeks to four.
- Direct labor is reduced by 70 percent.
- Work-in-process has been cut from $17 million to $7 million.

The surface-mount technology cell contains four lines. Boards pass along the first two to receive active components on the top side, then pass along the other lines to get passive components on the bottom side. As a board advances along the line it gets an application of solder paste on which components are placed, then is cured, cleaned, and soldered by the vapor-phase process and cleaned again. Passive components on the bottom side are wave-soldered. One reason Allen-Bradley chose Panasonic assembly equipment is that the line can be enlarged easily. Additional equipment can be inserted without disruption to increase production as volume grows.

Like the famous Allen-Bradley pyramid, CIM line architecture includes five levels: process, station, cell, center, and plant. At bottom is the process equipment of the Panasonic assembly line. Above that are five PLCs that monitor temperature and other process conditions, control the Panasonic pick-and-place robots, and communicate with the cell control.

The cell control, a Vista 2000 industrial computer, supervises work of the assembly line. It stores all assembly programs (10 for every board through the cell) and downloads them to PLCs. It verifies process set-up and tooling (some machines have 100 pieces of tooling). It verifies the process (some soldering processes have 20 parameters to watch). The cell tracks boards from bar-code input and radio-frequency identification of magazines that carry them about. The cell collects data from vision and other sensors for SPC (statistical process control) to provide fast response to problems and passes information to the center computers for long-term analyses.

The architects of the SMT/CIM line have come to understand the role of the center level in developing this installation. The center includes a VAX cluster with an Oracle database-management system. These computers schedule the cell to reduce work in process (WIP) and provide the all-important interfaces to engineering and computer-aided design systems. The computers also handle off-line creation of programs for robots. Finally, the VAX cluster ties into the corporate MRP computers for materials and inventory planning and key business information.

In a typical transfer of information, a program for pick-and-place robots, for example, begins with engineering at Highland Heights. CAD files there pass shape, position, part, and fit information over Ethernet to a VAX at Twinsburg. The VAX validates the process and syntax, then passes information into the Oracle database to create robot programs. The program is finally transferred over Ethernet to the Visa 2000 industrial computer.

The five-person team responsible for integration used several tricks to make information flow through this hierarchical pipeline without having to create vast amounts of software. The team has created a tool kit make other vendors' equipment look like Allen-Bradley PLCs. The kit has reduced the amount of custom code that must be written for machine interfaces, and it makes the use of standard software packages easier.

In addition, the team has insulated applications from machine interfaces. Instead of, say, three applications talking to a soldering machine as was done in the past, all data is deposited in the cell database. Multiple applications that need to use the data refer to that database. Machine-interface software is tricky to write and best minimized. The approach of interfacing through PLCs or cell integrator also keeps the system flexible. Interfaces

stay fixed while applications change.

Compression of time to market, an Allen-Bradley goal with this installation, is accomplished in large measure by parallel development of design and manufacturing information. The bill-of-materials (BOM) contains all documentation needed to produce a board and is prepared as the design develops. Among other advantages, early BOM development allows vendors to get lead time in supplying parts. All four product groups affiliated with Twinsburg use common data formats and procedures as they produce designs on four different CAD systems.

The design process begins with a part-numbering system (which drives the entire process). Circuit and mechanical designs evolve simultaneously and undergo simulations to verify a concept and to assure fit of electrical circuits to mechanical parts. Standardized CIM files are also produced in engineering, engaging engineers in manufacturing information activities new to them.

When the design is right, it is sent to Twinsburg electronically where part programs are generated by the VAX through the relational database. Test, tooling, and other essential manufacturing information is downloaded to the cell control. Engineering does not produce breadboard or prototype models. Prototypes run on the manufacturing line. The goal is to have design and manufacturing information absolutely perfect when it leaves engineering, ready for the SMT line.

Allen-Bradley's SMT design team is the first to say (and say vigorously) that much remains to be done. In a few months artificial intelligence will be integrated into the line to improve scheduling. AI will help balance the line and optimize machine utilization as emergencies occur—a machine goes down, for example. Systems engineers are also looking for good decision-support tools. CIM produces a lot of information that is hard to digest and act upon quickly. CIM definitely is an evolutionary process. The trick is to design hardware and software systems that can accommodate change without disruption.

MARKETWATCH

ACQUISITIONS

BUYER	BUSINESS	COMPANY ACQUIRED	BUSINESS	AMOUNT
3Com 1365 Shorebird Way Mountain View, CA 94039 (415) 961-9602	Manufactures local-area network systems and software	Communications Solutions 992 S. Saratoga/Sunnyvale Rd. San Jose, CA 95129 (408) 725-1568	Develops IBM-compatible terminal-emulation and office-communications software	$10 million (est.)
Anacomp 11550 N. Meridian St. Carmel, IL 46032 (317) 844-9666	Develops industrial system software for purchasing and traffic control	Xidex 5100 Patrick Henry Dr. Santa Clara, CA 95050 (408) 988-3472	Manufactures precision magnetic-media equipment	$400 million
CAE Industries Box 30 Toronto, Ontario M5J 2J1 (416) 865-0070	Manufactures defense equipment	Singer Link Division 11800 Tech Rd. Silver Spring, MD 20904 (301) 622-4400	Manufactures non-flight-simulation systems	$550 million
Cincinnati Bell 201 East 4th St. Cincinnati, OH 45201 (513) 397-9900	Provides voice, data, and video information services	Vanguard Technologies Intl. 10530 Rosehaven St. Fairfax, VA 22030 (703) 273-0500	Provides various information services	$71 million
Claris 440 Clyde Ave. Mountain View, CA 94043 (415) 960-1500	Develops software for the Apple II and Macintosh computers	Nashoba Systems 1157 Triton Dr. Foster City, CA 94404 (415) 578-1974	Makes database software for Apple Macintosh computers	Not disclosed
George Fischer 555 Business Center Dr. Mount Prospect, IL 60056 (312) 635-7990	Develops manufacturing technologies	Raycon 2311 Green Rd. Ann Arbor, MI 48105 (313) 769-2614	Manufactures and develops electrical-discharge machines and industrial laser systems	Not disclosed
Intl. Microcomputer Software 1299 Fourth St. San Rafael, CA 94901 (415) 454-7101	Manufactures computer graphics systems and software	Bytcom 2169 Francisco Blvd. San Rafael, CA 94901 (415) 485-0700	Manufactures telecommunications equipment	Not disclosed
Martin Marietta 6801 Rockledge Dr. Bethesda, MD 20817 (301) 897-6000	Manufactures defense and electronic equipment	Gould Ocean Systems Div. 18901 Euclid Ave. Cleveland, OH 44117 (216) 486-8300	Manufactures undersea weapons, telecommunications, and surveillance equipment	Not disclosed
Rockwell International 600 Grant St. Pittsburg, PA 15219 (412) 565-2000	Manufacturers defense systems, commercial electronics, and avionics systems	Communication Mnfg. 3300 East Spring St. Long Beach, CA 90801 (213) 426-8345	Makes local-area network systems	$40 million
Rockwell International 600 Grant St. Pittsburg, PA 15219 (412) 565-2000	Manufactures defense systems, commercial electronics, and avionics systems	Communication Machinery 125 Cremona Dr. Santa Barbara, CA 93117 (805) 968-4262	Manufactures local-area network systems and software	Not disclosed
Samsung Electronics 5150 Great American Pkwy. Santa Clara, CA 95050 (408) 980-1630	Manufactures consumer electronics and personal-computer products	Micro Five 3550 Hyland Ave. Costa Mesa, CA 92626 (714) 957-1517	Manufactures microcomputers	Not disclosed

LEADING 100

COMPANY (SYMBOL/EXCHANGE)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE		LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
				LAST QUARTER ($)	CHANGE FROM 1 YEAR AGO				
AEROSPACE									
Ronson (RDNC/NASDAQ)	1/11	7.6	2.56	.17	NC	—	6.1	2.84	34.8
Mdtec (MXC/AMEX)	2/20	5.0	5.25	.13	1200.0	—	22.8	.22	23.9
Hexcel (HXL/NYSE)	3/12	2.9	36.00	.65	30.0	.44	16.6	.71	380.8
Boeing (BA/NYSE)	4/10	1.5	59.63	1.05	40.0	1.60	16.9	.05	16,436.0
Raytheon (RTN/NYSE)	5/13	.4	65.38	1.84	22.7	2.00	9.7	.02	7,981.7
Northrop (NOC/NYSE)	6/16	–.4	29.88	2.97	241.4	1.20	7.3	.03	6,022.5
Fairchild Ind. (FEN/NYSE)	7/19	–1.1	10.63	.32	–45.8	.20	NE	2.39	407.4
Watkins Jhnsn. (WJ/NYSE)	8/21	–1.5	25.13	.57	26.7	.40	11.6	.22	275.6
McDonnell Doug. (MD/NYSE)	9/9	–1.9	63.13	1.83	–23.4	2.56	8.5	.25	13,331.5
Rohr Ind. (RHR/NYSE)	10/26	–2.1	29.13	.49	206.3	—	16.8	.43	853.7
CHEMICALS									
Bolchem (BLCC/NASDAQ)	1/81	16.0	4.06	.10	42.9	.03	13.1	.21	7.4
Hawkins Chem. (HWKN/NASDAQ)	2/76	10.0	8.25	.16	45.5	.12	13.8	.01	37.1
Kindrk (KIN/AMEX)	3/23	8.9	4.63	.11	10.0	—	NE	1.08	28.9
Fst. Miss. (FRM/NYSE)	4/12	7.9	17.13	.67	39.6	.24	10.6	.36	318.1
Petrolite (PLIT/NASDAQ)	5/72	7.6	24.75	.33	–8.3	1.12	23.1	.00	301.6
Publicker Ind. (PUL/NYSE)	6/63	6.4	2.00	.01	NE	—	NE	3.04	66.4
Wellmon (WLMN/NASDAQ)	7/29	6.1	39.00	.68	51.1	—	18.0	.40	290.1
MacDermid (MACD/NASDAQ)	8/54	5.1	26.00	.64	36.2	.60	13.5	.24	128.7
Immucor (BLUD/NASDAQ)	9/26	4.5	7.38	.06	.0	—	30.7	.12	8.3
Colgon Corbon (CRBN/NASDAQ)	10/13	3.9	53.50	.83	62.7	.20	21.8	.25	193.7
COMMUNICATIONS									
Intellicall (INCL/NASDAQ)	1/18	67.3	9.00	.11	57.1	—	23.7	.00	25.3
ALC Comm. (ALCC/NASDAQ)	2/70	49.3	2.06	–.35	–100.0	—	NE	2.44	391.1
Philipp LD Tel. (PHI/AMEX)	3/31	21.1	10.75	23.31	6550.0	.15	.3	2.61	7,246.0
NW Telecom. (NOWT/NASDAQ)	4/5	16.3	28.50	1.93	819.0	.66	10.6	2.50	51.1
Teleconnect (TNN/NYSE)	5/69	14.2	17.00	NA	NA	—	NA	NA	NA
CTEC (CTEX/NASDAQ)	6/38	12.2	39.00	.81	35.0	.92	15.1	1.24	137.1
Phonemote (PHMT/NASDAQ)	7/55	10.9	3.75	.21	600.0	—	8.7	4.50	121.2
Graphic Scan. (GSCC/NASDAQ)	8/63	10.2	8.13	–.02	NE	—	6.7	1.79	113.9
Advantage Cos. (ADCO/NASDAQ)	9/68	10.1	4.13	.01	–75.0	—	45.8	1.34	22.2
C TEC (CTEXB/OTC)	10/37	10.1	38.00	NA	NA	—	NA	NA	NA
COMPUTERS									
Wells Americdn (WAC/AMEX)	1/96	50.0	2.25	–.04	–100.0	—	NM	.03	15.9
Vermont Res. (VRE/AMEX)	2/11	36.2	1.88	–.44	NE	—	NE	.00	4.3
Moss. Comp. (MSCP/NASDAQ)	3/156	28.7	4.75	.01	–85.7	—	19.8	.05	79.6
Genisco Tech. (GES/AMEX)	4/177	26.6	2.38	–1.63	NE	—	NE	.02	40.6
IPL Sys. (IPLSA/NASDAQ)	5/26	23.5	2.63	.07	–12.5	—	16.4	.00	7.2
Miltope Grp. (MILT/NASDAQ)	6/7	22.6	9.50	.03	–57.1	—	NE	.77	63.4
CSP (CSPI/NASQAQ)	7/107	19.9	6.75	.02	.0	—	56.3	.00	9.5
Gen. Automtn. (GA/AMEX)	8/174	18.1	1.63	–.15	–100.0	—	NE	.10	50.1
Elbit Comp. (ELBTF/NASDAQ)	9/168	16.0	4.50	.11	–56.0	.14	4.2	.17	179.7
Adoptec (ADPT/NASDAQ)	10/157	15.8	5.50	.04	–77.8	—	15.3	.00	57.8
DRUG MANUFACTURERS									
Invitron (INVN/NASDAQ)	1/14	36.0	8.50	NC	NC	—	NE	.88	NC
Hycor Biomed. (HYBD/QTC)	2/48	30.6	1.88	.03	50.0	—	20.8	.15	7.5
Incstor (ISR/AMEX)	3/2	28.3	10.75	.16	433.3	—	27.6	1.32	15.9
Adv. Magnetics (ADMG/NASDAQ)	4/10	20.0	9.00	.03	–81.3	—	60.0	.00	4.0
Smith Labs (SMLB/NASDAQ)	5/12	19.0	2.38	.03	50.0	—	NE	.11	11.2
Nature's Sunsh. (AMTC/NASDAQ)	6/30	18.4	14.50	.28	47.4	.10	13.3	.02	41.2
Collab. Res. (CRIC/NASDAQ)	7/63	16.8	4.38	.00	NE	—	NE	.00	14.4
Amgen (AMGN/NASDAQ)	8/85	15.7	31.25	.02	–33.3	—	NM	.10	49.0
E Z EM (EZEM/NASDAQ)	9/56	13.6	12.50	.26	8.3	—	14.5	.00	59.8
Synbiotics (SBIQ/NASDAQ)	10/72	13.3	8.50	–.01	–100.0	—	NM	.01	5.8

The HIGH TECHNOLOGY BUSINESS Leading 100 lists the 10 companies in each of 10 industries that had the highest stock gain over the previous month (figures as of 8/10/88).

NA = Not available NE = Negative earnings NC = Not calculable NM = No meaningful figure

COMPANY (SYMBOL/EXCHANGE)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE		LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
				LAST QUARTER ($)	CHANGE FROM 1 YEAR AGO				
ELECTRONICS									
Tech. Ops. Sev. (TOC/AMEX)	1/182	60.0	6.00	.15	114.3	—	14.3	.00	14.0
Kevlin Micro. (KVLM/NASDAQ)	2/140	29.3	3.88	.07	133.3	—	NM	.00	7.8
Plantranics (PLX/NYSE)	3/55	28.1	26.75	.57	26.7	.16	15.3	.17	121.0
Sony (SNE/NYSE)	4/166	24.0	50.38	.30	NE	.29	42.0	.24	11,509.9
La Pointe Ind. (LPI/AMEX)	5/84	23.6	3.25	.02	NE	—	NE	.35	4.2
Canrad (CNRD/NASDAQ)	6/42	22.7	12.88	.29	-27.5	—	18.1	1.17	51.0
Gen. Kinetics (GKIE/NASDAQ)	7/24	20.7	4.38	-.19	-100.0	—	NE	.29	7.7
LaBarge (LB/AMEX)	8/73	20.2	1.13	.00	-100.0	—	7.0	5.03	58.0
Lowrance Elec. (LEIX/NASDAQ)	9/141	19.0	2.38	-.06	-100.0	—	NE	.07	44.4
Dyansen (DYAN/NASDAQ)	10/205	18.4	2.44	.09	80.0	—	11.6	.49	29.1
HEALTH									
Trimedyne (TMED/NASDAQ)	1/11	43.5	22.25	.23	475.0	—	34.8	.05	24.9
Bio. Medicus (BMDS/NASDAQ)	2/34	25.1	9.38	.11	NE	—	30.2	.00	13.6
Diasanic (DIA/AMEX)	3/12	22.2	2.75	.05	.0	—	15.3	.28	273.1
Phoenix Med. (PHNX/NASDAQ)	4/79	19.5	12.25	.22	15.8	—	17.8	.38	16.3
Spectran (SPTR/NASDAQ)	5/119	19.0	1.19	-.09	NE	—	NE	.18	3.6
Waters Inst. (WTRS/NASDAQ)	6/114	18.3	4.00	-.03	-100.0	.08	23.5	.07	12.0
AOAC Labs (ADAC/NASDAQ)	7/6	17.6	3.75	.12	500.0	—	17.9	.10	73.2
Biomet (BMET/NASDAQ)	8/70	14.6	29.50	-.04	-100.0	—	41.0	.00	97.6
Ballard Med. (BMED/NASDAQ)	9/95	14.3	16.00	.19	111.1	—	32.0	.00	14.0
Medex (MDEX/NASDAQ)	10/44	14.2	11.00	.19	35.7	.08	17.2	.09	26.1
METALS FABRICATION									
Am. Locker (ALGI/NASDAQ)	1/41	27.3	7.00	.24	-25.0	.28	5.9	.03	23.9
ABS Ind. (ABSI/NASDAQ)	2/12	22.4	15.00	.15	-58.3	.80	53.6	1.66	20.8
Groff Ind. (GROF/NASDAQ)	3/27	16.7	19.25	.32	-20.0	.16	13.0	.00	39 3
Metex (MTX/AMEX)	4/36	15.8	11.00	.93	365.0	—	7.6	.18	32.1
Columbia Gen. (CLGN/OTC)	5/11	13.8	8.25	.15	-44.4	—	4.3	.42	54.1
MLX (MLXX/NASDAQ)	6/8	11.8	2.94	.11	22.2	—	NE	8.31	385.5
Cyclops Ind. (CYC/NYSE)	7/29	8.8	27.75	1.20	NE	—	NM	43.33	726.2
Zero (ZRD/NYSE)	8/15	6.3	17.00	.31	29.2	.40	15.0	.12	145.4
Fla. Steel (FLS/NYSE)	9/13	4.5	49.13	1.27	49.4	1.00	15.1	.61	454.9
Deltak (DLTK/NASDAQ)	10/37	4.2	6.25	.20	-65.5	—	15.2	.48	27.7
SCIENTIFIC AND ELECTRONIC INSTRUMENTS									
Laser Phata (LAZR/OTC)	1/7	48.5	3.06	.08	NE	—	NE	1.45	8.2
Nuclear Data (NDI/AMEX)	2/86	42.0	1.25	-2.28	NE	—	NE	.08	51.0
Matrix (MAX/AMEX)	3/12	36.7	9.75	-.03	-100.0	—	NE	.89	105.0
Laser Prec. (LASR/NASDAQ)	4/10	27.3	7.00	.11	NE	—	25.9	.01	23.2
Medar (MDXR/NASDAQ)	5/38	16.0	3.63	NC	NC	—	NE	.79	NC
Tinsley Labs (TNSL/OTC)	6/56	12.5	6.75	.26	NE	—	22.5	.31	7.0
Knago (KNO/NYSE)	7/57	12.1	15.00	.26	-23.5	.30	NM	.10	50.1
Buehler Int. (BULR/NASDAQ)	8/82	11.4	9.75	.17	30.8	.28	13.0	.05	70.0
Ariz. Inst. (AZIC/NASDAQ)	9/9	10.5	5.25	.00	-100.0	—	40.4	.17	10.0
Chronar (CRNR/NASDAQ)	10/83	10.0	8.25	-.14	NE	—	NE	.75	23.5
SOFTWARE AND DATA PROCESSING									
Scicom Data (SCIE/NASDAQ)	1/78	42.9	10.00	.18	20.0	—	9.8	.56	16.3
Micro Pro Int. (MPRD/NASDAQ)	2/132	35.2	3.38	-.13	-100.0	—	NE	.00	42.7
H. Jack Assoc. (JKHY/NASDAQ)	3/138	33.3	4.00	.17	466.7	—	23.5	.18	17.1
Finl. Ind. (FNIN/OTC)	4/71	30.4	7.50	.09	-40.0	—	10.9	.00	.8
MPSI Sys. (MPSG/NASDAQ)	5/144	27.3	3.50	.26	766.7	—	14.6	.02	35.1
Comp. Data Sys. (CPTD/NASDAQ)	6/9	24.1	16.75	.25	19.0	.12	14.7	.73	66.0
Altai (ALTI/NASDAQ)	7/16	23.5	5.25	.07	250.0	—	18.1	.00	13.2
Micros Sys. (MCRS/NASDAQ)	8/11	22.9	2.31	.01	NE	—	NE	.31	19.3
Continuum (CTUC/NASDAQ)	9/126	20.0	12.00	.15	25.0	—	20.0	.10	62.7
CIS Tech. (CISIF/NASDAQ)	10/137	19.0	1.19	-.06	NE	—	NE	.04	.1

SOURCE: MEDIA GENERAL FINANCIAL SERVICES

JOINT VENTURES

COMPANY	COMPANY	PURPOSE	CONTACT
Advanced Genetic Sciences	Department of Agriculture and Rural Affairs, Victoria, Australia	To develop better crop varieties and enhance food production and quality control.	Advanced Genetic Sciences 6708 San Pablo Ave. Oakland, CA 94608 (415) 547-2395
Allied-Signal Aerospace, Bendix Electric Power Division	Ferranti Aircraft Equipment	To form Ferranti/Bendix Power Generation Ltd., which will manufacture electric-power generating systems for the aerospace industry.	Allied-Signal Box 224SR Morristown, NJ 07960 (201) 4SS-4674
BioTechnica International	Wacker-Chemie GmbH	To develop genetically engineered microbe systems to produce chemicals and enzyme products.	BioTechnica International 8S Balton St. Cambridge, MA 02140 (617) 864-0040
British Aerospace	Rockwell International, North American Aircraft Division	To form a team to compete for the U.S. Air Force's proposed Tanker Transport Training System program.	British Aerospace 2101 L Street N.W. Washington, D.C 20037 (202) 857-0125
CompuDrug Ltd.	Kiser Research	To form CompuDrug USA, which will develop and sell expert-system software for use in chemical and pharmaceutical research.	Compudrug USA Box 202078 Austin, TX 78720 (S12) 331-0880
Destiny Technology	Acer Technologies	To develop and market laser-printer technology and products.	Destiny Technology 930 Thompson Place Sunnyvale, CA 94086 (408) 733-3171
MacroChem	Alcolac	To test MacroChem's patented hydrophilic-lipophilic monomers, a type of water-soluble polymer, for new uses.	MacroChem 21X Olympia Ave. Woburn, MA 01801 (617) 938-6S10
Silvar-Lisco	HHB Systems	To develop a new product combining technology from HHB's Cadat simulation system and Silvar-Lisco's Helix behavioral simulator.	Silvar-Lisco 1080 Marsh Rd. Menlo Park, CA 9402S (41S) 324-0700
Symbolics	Sony Microsystems	To form a partnership in which Symbolics will sell and service Sony's News series of Unix technical workstations.	Symbolics 11 Cambridge Center Cambridge, MA 02142 (617) 621-7S90
Union Carbide	Allied-Signal	To supply technology, systems, and services to the petroleum-refining, petrochemical, gas-processing, and energy industries worldwide.	Union Carbide 39 Old Ridgebury Rd. Danbury, CT 06817 (203) 794-698S
Union Carbide	BP Chemicals International	To form American Acetyls, which will market vinyl acetate worldwide and supply acetic acid in the United States.	Union Carbide 39 Old Ridgebury Rd. Danbury, CT 06817 (203) 794-698S
Union Carbide	General Electric	To create GE-Carbide Silicones Inc., which will combine the two companies' worldwide silicones businesses.	Union Carbide 39 Old Ridgebury Rd. Danbury, CT 06817 (203) 794-6985
University of Cincinnati, College of Business Administration	Mitsuru Wakabayashi of Nagaya University	To study Japanese manufacturing ventures in the United States.	UC College of Bus. Admin. ML 16S Cincinnati, OH 4S221 (513) 475-7120

New Products

OFFICE PRODUCTS

NP 8580 copier. Makes 80 copies/minute; feeds as many as 50 originals; creates one- or two-sided copies. The machine has a four-way paper supply that holds 2,500 sheets. Features include zooming, margin adjustment, and reduction or enlargement by 64 to 142 percent. $22,000. Canon U.S.A. Inc., 1 Canon Plaza, Lake Success, NY 11042. (800) 652-2666. *Circle 1.*

ACD/MIS phone manager. This system automatically distributes telephone calls and provides reports and data to help managers maximize resources. It integrates PBX and computer functions. Price varies. Fujitsu Business Communications, 3190 Mira Loma Ave., Anaheim, CA 92806. (714) 630-7721. *Circle 2.*

Call Analyzer software. Equips an IBM AS/400 computer to handle call accounting and traffic analysis. Provides reports to help managers allocate expenses, recover phone costs, and control phone abuse. From $3,500. Instor Corp., 199 Jefferson Dr., Menlo Park, CA 94025. (415) 326-9830. *Circle 3.*

DiamondTel 90X cellular phone. This 18-ounce, portable unit has batteries for an hour and a half of talking time or 13 hours of standby power. The phone incorporates an antenna and stores 100 phone numbers, each as long as 36 digits. $2,145. Mitsubishi Electric Sales America, 800 Biermann Court, Mount Prospect, IL 60056. (312) 298-9223. *Circle 4.*

F-32 fax machine. Handles moderate-volume use. For automatic dialing, the machine stores 64 phone numbers with as many as 35 digits each. It provides operating prompts, activity reports, and confirmation reports in English, Spanish, or French. Compatible with Group 2 and 3 facsimile machines; stores confidential documents in memory. $2,195. Murata Business Systems, 4801 Spring Valley Rd., Dallas, TX 75244. (214) 392-1622. *Circle 5.*

FocusMail phone-message system. Stores 15 hours of voice messages. The computerized system integrates with PBX systems and works with all touch-tone phones. It offers a personal greeting on forwarded calls, message waiting, call screening, and a daily message reminder. Price varies. Fujitsu Business Communications, 3190 Mira Loma Ave., Anaheim, CA 92806. (714) 630-7721. *Circle 6.*

NP 9330 copier. Combines digital scanning and laser printing to scan 256 tonal gradations. Reduces as much as 35 percent and enlarges as much as 800 percent. The system offers contour and italic functions, area designation, automatic zoom, mirror mode, image repeat, character input, and positive/negative imaging. $19,500. Canon U.S.A. Inc., 1 Canon Plaza, Lake Success, NY 11042. (800) 652-2666. *Circle 7.*

TF-451 fax machine. Uses plain paper and offers error correction when operating in Group 3 mode. Stores 99 phone numbers and has 33 one-touch keys and a liquid-crystal display. With a memory card, the machine provides a security mailbox and additional memory. $3,995. Toshiba America Inc., Facsimile Products Group, Copier Products Division, 9740 Irvine Blvd., Irvine, CA 92718. (714) 583-3626. *Circle 8.*

USGH 934T phone interface. Allows external calls to and from Ring intercom stations via the public telephone network. Calls enter the system from touch-tone phones and are directed to an intercom station or zone page group. Price varies. Ring Group Inc., 230 Community Dr., Great Neck, NY 11021. (800) 645-9690; in N.Y., (516) 487-0250. *Circle 9.*

COMPUTER HARDWARE

ANC-500 Ethernet repeater. Extends an Ethernet local-area-network cable segment more than 500 meters; meets IEEE 802.3 specifications. The repeater also connects four cable segments. $1,450. American Network Connections Inc., 179 E. Tasman Dr., San Jose, CA 95134. (408) 922-1600. *Circle 10.*

C1435-AS color monitor. This 14-inch monitor can be customized to work with any computer graphics system. It operates with the most popular graphics boards and has 800×560-pixel resolution. Less than $900. Pixelink Corp., 9 Kane Industrial Dr., Hudson, MA 01749. (508) 562-4803. *Circle 11.*

LDP-Cache disk controller. A SCSI controller board with an intelligent interface to peripheral units. The board provides between 256 kilobytes and one megabyte of cache memory, and transfers data at a rate of four megabytes/second. $649. Lomas Data Products Inc., 182 Cedar Hill St., Marlborough, MA 01752. (508) 460-0333. *Circle 12.*

M1928LFT fault-tolerant modem. A 19,200-bit/second, synchronous, leased-line unit that constantly analyzes the telephone line. The modem adapts its speed and/or changes its transmission facility to either a dial line or alternate leased line. $5,295. Fujitsu America Inc., 77 Rio Robles, San Jose, CA 95124. (800) 422-2878; in Calif., (408) 434-0460. *Circle 13.*

MegaTrend/2 color monitor. A 20-inch desktop monitor that plugs into the Macintosh II color video card with an optional pin adapter. Offers 640×480-pixel resolution with as many as 256 simultaneous colors. $2,295. Intecolor, 225 Scientific Dr., Norcross, GA 30092. (404) 449-5961. *Circle 14.*

Model 286 personal computer. Includes a 12-megahertz 80286 processor, a 110-megabyte Winchester disk drive, and a 1.2-megabyte floppy drive. The computer also has a user-accessible receptacle that holds a 30-megabyte Personal Data Pac hard disk drive. Price not available. Tandon Computer Corp., 405 Science Drive, Moorpark, CA 93021. (800) 556-1234, extension 171; in Calif., (805) 523-0340. *Circle 15.*

Pinwriter dot-matrix printers. Two 24-pin models that print 265 characters/second in draft mode and 90 characters/second in letter-quality mode. Both models have a buffer that handles 40 pages of text, and both offer seven resident typefaces. The 80-column P5200 costs $799; the 136-column P5300 is $1,049. Optional eight-color printing costs $129. NEC Information Systems Inc., 1414 Massachusetts Ave., Boxborough, MA 01719. (800) 343-4418; in Mass., (508) 264-8000. *Circle 16.*

Smartmodem 9600 modem. Made for local-area networks and mainframe systems, providing full-duplex, synchronous/asynchronous operation at 9,600 and 4,800 bits/second. The modem uses leased lines and offers dial-up communications through the CCITT V.32 standard. $1,999. Hayes Microcomputer Products Inc., Box 105203, Atlanta, GA 30348. (404) 449-8791. *Circle 17.*

COMPUTER SOFTWARE

Axle expert-system builder. Illustrates basic and advanced techniques needed to develop expert systems. One program guides first-time developers, another shows how to build an expert system, and a third builds graphic interfaces to the knowledge base. Other programs provide source code for such expert-system components as simulation, Gantt charts, model editors, and networks. Runs on IBM-compatible and Compaq 386 computers. $1,995. Gold Hill Computers Inc., 26 Landsdowne St., Cambridge, MA 02139. (617) 621-3300. *Circle 18.*

CFO Advisor financial analyzer. Helps plan corporate financial activity, including budgeting, profit analysis, funding requirements, and consolidations. Solves more than 600 financial equations; supports analysis of cost of sales, fixed assets, and operating expenses. Runs on IBM-compatible computers. $995. Financial Feasibilities, 9454 Wilshire Blvd., Beverly Hills, CA 90212. (800) 752-5556, in Calif., (800) 247-4452. *Circle 19.*

Fastwire II file-transfer utility. Lets personal computers exchange information at 50,000 bytes/second through serial or parallel cable. Backs up and manages files on a hard disk; three modes accommodate various user skill levels. Runs on IBM-compatible computers. $129.95. Rupp Brothers, Drawer J, Lenox Hill Station, New York, NY 10021. (212) 517-7775. *Circle 20.*

GoScript software printer. Lets IBM-compatible computers print PostScript language files on dot-matrix, ink-jet, and laser printers. Includes 13 typefaces compatible with Apple LaserWriter fonts. Needs computer wiith 60 kilobytes of memory and a hard disk. $195. LaserGo Inc., 9235 Trade Place, Suite A, San Diego, CA 92126. (619) 530-2400. *Circle 21.*

Videostack interactive-video kit. Creates interactive video programs using HyperCard technology. The software offers drivers for NTSC and PAL players, including those from Pioneer and Sony. Features include automatic installation, function customization, and frame tagging. $100 with drivers; drivers alone are $50. Voyager Company, 2139 Manning Ave., Los Angeles, CA 90025. (213) 474-0032. *Circle 22.*

COMMERCIAL/INDUSTRIAL

GS densitometry software. Two versions adjust baselines, smooth curves, and expand scans in two directions. The software has a manual mode and two automatic modes for peak integration, plus windows for displaying three scans at once. Users can align two peaks in separate windows and superimpose one set of data on another. Macro subroutines allow unattended repeat data processing on as many as 15 scans. Version GS 365 runs on IBM-compatible computers; version GS 370 works with Macs. $1,700 each. Hoefer Scientific Instruments, 654 Minnesota St., San Francisco, CA 94107. (800) 227-4750; in Calif., (415) 282-2307. *Circle 23.*

G Series laminating analyzers. Three models measure the adhesion of liquids to solid surfaces to calculate surface energies in coating, bonding, or laminating processes. Model G-I works at standard temperatures; Model G-II h andles wettability studies to 300° C; Model G-III performs wettability studies involving advancing and receding angles. All three systems have protractor and micrometer scales, plus colored glass filters. $5,770, $6,920, and $7,360, respectively. Kernco Instruments Company Inc., 420 Kenazo Ave., El Paso, TX 79927. (800) 325-3875; in Tex., (915) 852-3375. *Circle 24.*

Platinous G low-humidity testers. Four test chambers that have dehumidification systems to create and maintain conditions such as 5 percent relative humidity at 40° C and 15 percent relative humidity at 10° C. A separate refrigeration unit allows precise control of temperature and humidity, and a sensing system permits 500 hours of continuous operation. $20,000 to 40,000. Espec Corp., 400 D-1 Corporate Court, South Plainfield, NJ 07080. (201) 753-5900. *Circle 25.*

PM 8238 data recorder. This 30-channel, multiple-point recorder gathers data over weeks or months, recording 30 simultaneous inputs in three seconds. It displays data as graphs or number tables. The unit offers 1,000-dot resolution, 10-inch wide plotting, and a range of chart transport speeds. Includes a thermal printer. $5,500. John Fluke Manufacturing Company Inc., Box C9090, Everett, WA 98206. (206) 347-6100. *Circle 26.*

Pocket microscope. Measures about 5×1×¾ inches, with a ¾-inch field of view and a working distance of ¾ inches. The scope's acrylic base rests on the subject for stability. Includes a light source; runs on two AA batteries. $8.95. Edmund Scientific Company, 5554 Edscorp Bldg., Barrington, NJ 08007. (609) 547-3488. *Circle 27.*

Thermo Tracer 6T62/6T63 imager. Displays the temperature distribution of an object in shades of gray or in 256 color tones. Spans –50° to 2,000° C; works by remote control. The user can control focus and select the optical zoom filter; an optional swivel stage allows panning. Works with IBM-compatible computers. $55,000. Mikron Instument Co. Inc., 445 W. Main St., Wyckoff, NJ 07481. (201) 891-7330. *Circle 28.*

TI-24A monochrome camera. This black-and-white unit incorporates an electronic shutter to stop action and provide quality images of objects moving at high speed. The camera's shutter-speed controls are 1/250th, 1/5000th, or 1/1000th of a second. The solid-state instrument provides 728 horizontal and 492 vertical pixels for a resolution of 540×350 lines. Weighs less than one pound. $1,450. NEC America Inc., Broadcast Equipment Division, 1255 Michael Drive, Woodale, IL 60191. (312) 860-7600. *Circle 29.*

CONSUMER PRODUCTS

ABW1 wall switch. Handles on/off switching for a pair of speakers, a television, or audio systems. The device installs in light-switch mountings and fits under a wall plate. Handles 200 watts. $26.50 to $30. Sonance, 32992 Calle Perfecto, San Juan Capistrano, CA 92675. (714) 661-7558. *Circle 30.*

CX-1000U preamplifier. An integrated system with a 34-key infrared remote controller. The system has an 18-bit digital filter and two digital/analog converters. Includes inputs for 10 sources (including tape/DAT inputs), an input for analog audio tape, two compact-disc video inputs, and videocassette-recorder inputs. $1,199. Yamaha Electronics Corp., 6660 Orangethorpe Ave., Buena Park, CA 90620. (800) 492-6242. *Circle 31.*

DSP-3000 sound-field processor. This digital unit recreates the acoustics of 17 musical environments such as concert halls. It offers screen display, a choice of three input sources, and oversampling digital filters. The processor also provides movie-theater modes to analyze audio/visual environments. $1,899. Yamaha Electronics Corp., 6660 Orangethorpe Ave., Buena Park, CA 90620. (800) 492-6242. *Circle 32.*

DX-5500/7500 compact-disc players. These two models use optical technology to reduce power-supply variations in critical circuits. The DX-5500 offers four-times oversampling; Model DX-7500 increases the oversampling rate to eight times. Both players have linear 18-bit digital filters and digital/analog converters to improve sound reproduction. $600 and $700. Onkyo USA Corp., 200 Williams Dr., Ramsey, NJ 07446. (201) 825-7950. *Circle 33.*

KX-W302U/W202U cassette decks. Two dubbing decks with Dolby B and C noise reduction. Model KX-W302U has automatic reverse for its two transports and rewinds

automatically. The KX-202U allows one-touch dubbing, plus automatic bias and EQ adjustment. $449 and $349, respectively. Yamaha Electronics Corp., 6660 Orangethorpe Ave., Buena Park, CA 90620. (800) 492-6242. *Circle 34.*

M-30 in-wall speakers. Each has a four-inch woofer and a one-inch polycarbonate tweeter. Each speaker measures about 9×6½×2 inches and handles 75 watts. $300 to $400 per pair. Sonance, 32992 Calle Perfecto, San Juan Capistrano, CA 92675. (714) 661-7558. *Circle 35.*

Master Tracks Jr. sequencer. Made for use with the Apple IIGS computer. This product offers 64 recording tracks and step editing. It also allows users to perform cut/copy/paste song editing. The sequencer supports MIDI File format for storage. $149.95. Passport Designs Inc., 625 Miramontes Street, Half Moon Bay, CA 94019. (415) 726-0280. *Circle 36.*

Master Tracks Pro 3.0 sequencer. This unit works with the Apple Macintosh, IBM PC, and Atari ST computers. It provides 64 recording tracks for each sequence and supports two independent MIDI outputs for 32 channels. $395. Passport Designs Inc., 625 Miramontes St., Half Moon Bay, CA 94019. (415) 726-0280. *Circle 37.*

NS-1 Classics speakers. A two-way system with a 6¼-inch polypropylene-impregnated woofer and a cotton soft-dome tweeter. Each speaker measures about 8×15×11 inches. The frequency range spans 60 to 30,000 hertz. $499 apiece. Yamaha Electronics Corp., 6660 Orangethorpe Ave., Buena Park, CA 90620. (800) 492-6242. *Circle 38.*

PV Series projection TVs. These 46-inch-diagonal sets use a rear-projection system that offers 520 lines of resolution. Five models offer a 160° viewing angle and incorporate the Bose Acoustimass stereo sound system. $2,495 to $3,395. Zenith Electronics Corp., 1000 Milwaukee Ave., Glenview, IL 60025. (312) 391-7000. *Circle 39.*

Sensaphone 1100 monitor. Monitors AC power, temperature, smoke, and fire alarms. The system automatically sounds an alert, calls the owner by phone, and delivers a warning message. Can be configured to watch for other conditions such as intrusion, water level, and humidity. $300. Phonetics Inc., 101 State Rd., Media, PA 19063. (215) 565-8520. *Circle 40.*

Super-VHS VCRs. Model VRE550 records teletext for closed-captions, as well as teletext program listings, news stories, and stock quotes. It has six heads and provides 400-line resolution. The VRE510 has four heads and offers high-speed searching; this model scans the first five seconds of each recorded program. $1,149 and $599. Zenith Electronics, 1000 Milwaukee Ave., Glenview, IL 60025. (312) 391-7000. *Circle 41.*

T-9090 Mark II tuner. An FM tuner with a second antenna input for cable and satellite reception. The unit automatically monitors signal reception and includes a 20-station memory. A multiple-function display shows the scan threshold and station. $750. Onkyo USA Corp., 200 Williams Dr., Ramsey, NJ 07446. (201) 825-7950. *Circle 42.*

VC100/VC50 volume controls. Stereo controls made for installation in standard light-switch wallplates. The VC100 runs at 100 watts; the VC50, at 50 watts. $65 to $75 and $50 to $65, respectively. Sonance, 32992 Calle Perfecto, San Juan Capistrano, CA 92675. (714) 661-7558. *Circle 43.*

YM-300S monitor/receiver. Has a 30-inch square tube and a quartz synthesized tuner. Provides 560 lines of horizontal resolution; skips inactive channels. A quickview feature switches between channels. Accepts on-screen programming; includes 24-hour timer. Parents can lock channels and use a password to reenter. $1,999. Yamaha Electronics, 6660 Orangethorpe Ave., Buena Park, CA 90620. (800) 492-6242. *Circle 44.*

Digital Tanning; Computer Lips

LEISURE

Computerized tan control

PLANNING AHEAD for an escape to Florida? Watch for the early spring release of the Sunsor ultraviolet meter for safer tanning.

Because some ultraviolet rays are stronger than others, the Sunsor measures the sun's intensity to warn sunbathers about the amount of possible skin damage. The meter, a calculator-sized box with a liquid-crystal display, electronically measures ultraviolet-ray strength on a scale from 1 to 120. This scale is based on the amount of radiation it takes to cause a fair-skinned person to start to turn red after 20 minutes of exposure.

The meter is designed to measure the damage the sun can inflict on average, unprotected, untanned Caucasian skin. To get the most benefit from the meter, its maker, Sunsor Inc., suggests that people see a dermatologist or physician to determine their skin sensitivity.

The device is currently being tested for possible use by the National Weather Association in 24 cities. Sunsor Inc. hopes to eventually have Sunsor readings broadcast on the radio as commonly as the temperature reading on a weather broadcast.

The $20 device will be available at lotion counters in drug stores and other convenience stores. For more information, contact Sunsor Inc. The company is located at 2040 Avenue of the Stars, Fourth Floor, Century City, CA 90067. The telephone number is (213) 277-4331.

—Elizabeth Aaron

Watch those hazardous rays.

COMPUTING

Talking computer reads files

A NEW SOFTWARE program gives personal computers a speaking voice. The Monologue voice synthesizer acts as a low-cost proofreader for word-processing and spreadsheet programs. The program also accommodates electronic mail.

For businesses such as publishing, law, and accounting, the synthesizer can assist with proofreading by reading aloud documents stored as computer files so that a writer or editor can listen for accuracy. Doctors could use the Monologue program to read and check patient information. For disabled people, the program can act as a voice for professional and leisure reading.

Monologue is a memory-resident program that speaks in either a male or a female voice at a choice of nine volume levels. The product also includes a digital-to-analog converter built into a 2×2-inch box that plugs into the serial port of a personal computer. A set of earphones ensures that colleagues working nearby won't be disturbed by the computerized voice.

The $189.95 package works with IBM-compatible personal computers that operate under MS-DOS Version 2.1 or later versions. The program requires that the computer have at least 256 kilobytes of random-access memory.

The Monologue program is made by Dariana Inc., which is located at 3049 East Ocean, Building A, Long Beach, CA 90803. The company's telephone number is (213) 434-5935.

—Jennifer Christensen

Computers get a synthesized voice.

SECURITY

An alarm for computers

IMAGINE WALKING into your office and finding your computer gone, along with information gathered for a special project over the past month. A scary thought.

Current methods of discouraging computer theft such as locks, keys, chains, or advanced adhesives can be easily defeated with a cable cutter or a hammer. A company called Alarmcard offers an alternative—a half-size board that plugs into an IBM PC/XT/AT, PS/2 Models 25 and 30, and compatible personal computers. If the computer is moved or unplugged, a motion sensor attached to the board activates an alarm similar to that of a smoke detector. The alarm is loud, piercing, and sure to draw attention.

Software included with the Alarmcard board lets a person pick a password and arm or disarm the alarm through the keyboard. The alarm runs off a nine-volt battery that's good for about a year and a half and will sound the alarm for 30 hours. Like a smoke alarm, the board chirps when its battery begins to run down. The product also includes self-diagnostics, an on-screen battery check, and an alarm test.

Alarmcard is located at 14700 N.E. Eighth Street, Bellevue, WA 98007. Telephone (206) 747-0824.

—Kenan Woods

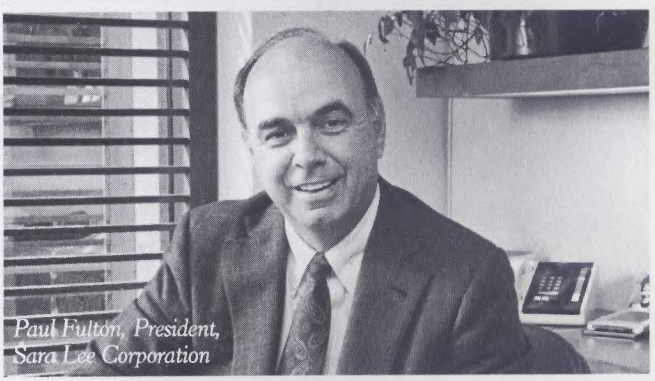
PHOTOGRAPHS BY ROBERT ARRUDA

Why North Carolina Businesses Expanded In... North Carolina.

Productivity: "There are a lot of things that certainly contribute to North Carolina being an excellent place to conduct business. There's the tremendous work ethic to consider and the community college training program is another. But what has been most important to us, at our first plant and the two we've opened since then, is the productivity. There's just a certain chemistry here in North Carolina and it all boils down to exceptional productivity." *Ben Eisenberger, President, Walter Kidde, Division of Kidde, Inc.*

Ben Eisenberger, President, Walter Kidde, Division of Kidde, Inc.

Commitment: "For Sara Lee Corporation, North Carolina has been the perfect place to expand. There's just an excellent attitude toward business. You find it on the local and state government level, you find it from your corporate neighbors and especially from the work force. Everyone we've dealt with has just been so willing, so commited to helping us grow." *Paul Fulton, President, Sara Lee Corporation*



Paul Fulton, President, Sara Lee Corporation

Resources: "When you're the tree growing company and more, you need good soil, good water, good climate, good people and good government. In North Carolina we have it all. In just 30 years our company has grown from a single plant site in Plymouth, to a full line of products and services throughout the state. Without the natural and human resources here in North Carolina, our growth would not have been possible." *J. Carl Jessup, Jr., Vice-President, The Weyerhaeuser Company*

J. Carl Jessup, Jr., Vice-President, The Weyerhaeuser Company

These are just a few of the companies who have found North Carolina to be the ideal climate for business. Ideal for manufacturing. Ideal for distribution. Ideal for servicing. An ideal climate for not only business but for people as well. So, if you're thinking about expanding, let us show you some more reasons to expand in North Carolina. Just contact Robert G. Brinkley, Assistant Director-Business/Industry Development Division, North Carolina Department of Commerce, 430 North Salisbury Street, Raleigh, NC 27611, phone (919)733-4151.

NORTH CAROLINA

The Better Business Climate

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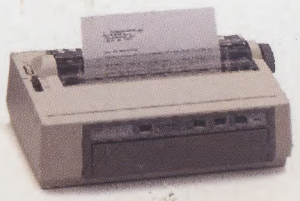

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